POWER

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Helpful Hints

System, the Free Lubricant

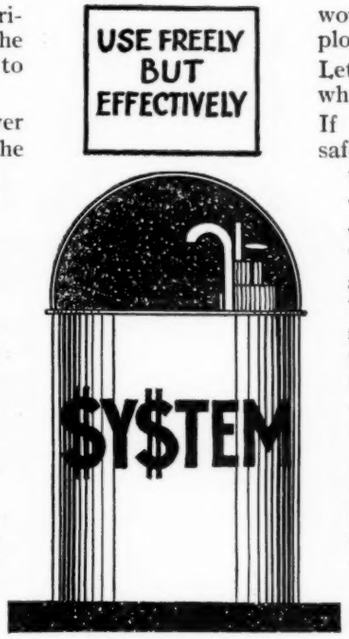
SYSTEM is the ancient and free lubricant for smooth, easy running, the liberal use of which may be applied to any business, calling or profession.

The application of system in the power plant is just as necessary as oil is to the moving machinery. It is for a similar purpose also—smooth, successful and economical operation.

System should be written with a double line through each S, depicting the dollars to be gained by the use of it.

The managements of all modern power plants and uptodate business houses insist strongly on the adoption of system in all lines of effort, knowing that work done in a methodical, systematic manner is much easier than when done in a haphazard, catch-as-catch-can way.

There should be a system adopted for oiling and cleaning machinery, reading meters, inspecting flywheels, trying gage-cocks, blowing water columns, testing safety valves, cleaning and inspecting boilers and for many other purposes about the plant.



If there should be an explosion of a boiler in your plant, and you were called upon to give evidence before a court or jury, suppose that you had adopted the rule of trying the safety valves to see if they were in the proper working order, every morning.

If the question were put to you, "Were the safety valves in working order on this boiler?"

You could answer confidently, "They were in the morning."

"How do you know they were in working order in the morning?"

"I made it a rule to test all safety valves every morning."

Such a reply would have some weight; your evidence would be of value to yourself, to your employer and to all concerned.

Let the same accident occur in the plant where system is unknown.

If the engineer were asked, "Were the safety valves in working order?" He would reply, "Yes, they were."

"Well, how do you know they were; when did you hear them blow last?"

"Oh, I would blow them every once in a while, perhaps every week or two."

This man's evidence would not have the same influence with a court or jury that the positive reply of the systematic man would have.

The terms "every now and then" and "every once in a while" are very elastic terms of time, and have the weak point of stretching out; and time glides along so rapidly that the intended few days often have become a few weeks and the weeks have become as many months, all under the hit-and-miss plan of operation.

Be regular and systematic in all duties where possible, and the labors will be lightened by this method.

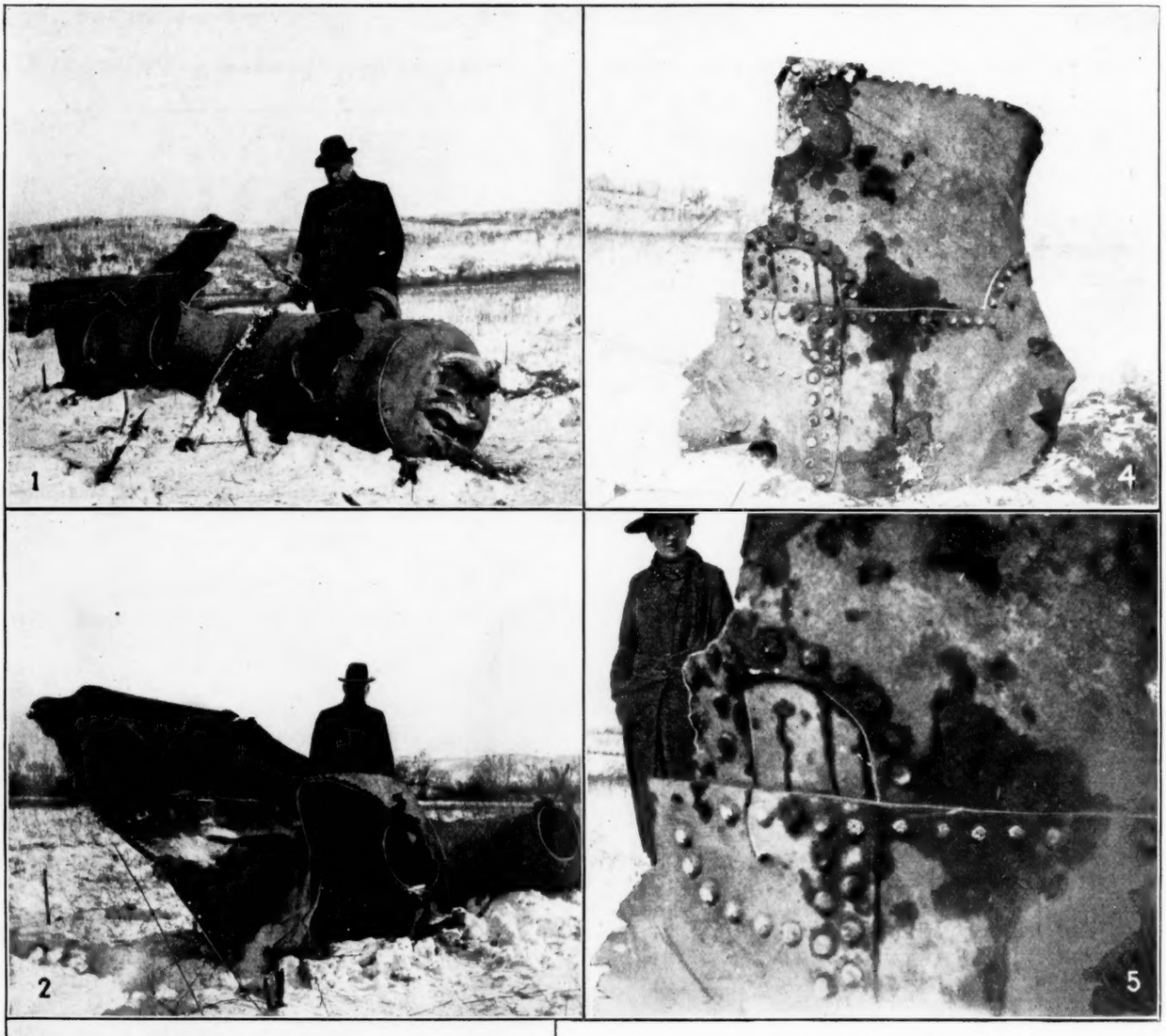
Have "a time and place for everything" and "everything in its time and place"—man as well as object. Of course man cannot expect to become as regular in methods as the smoke from the farmer's cookstove. The farmer claimed that after seventeen years' use the stovepipe became rusted and fell down, but the smoke, being so accustomed to the one path, just continued in the same course and out the chimney as usual. (Fable 7854.)

But infuse it, inject it, pump it in, pound it in or shoot it into your daily duties for smoother, safer and far more successful operation.

System for success.

Contributed by J. A. SNYDER, *Pittsburgh, Penn.*

Boilers of Steamer "Sam Brown" Explode at Huntington, W. Va.



VIEWS OF THE BOILER SHEETS AND THE STOP VALVE

Fig. 1—Showing the torn dome. Fig. 2—The shattered front sheets. Fig. 3—The stop valve, its wheel missing. Fig. 4—Torn sheets and their two patches. Fig. 5—A close view of the large patch

The "Sam Brown" was just about to pull out of Huntington, W. Va. (on the Ohio River), when the boiler shown exploded, killing 12 of the crew. The boat was about 18 yr. old and the boilers are said to have been the ones originally installed. The pressure carried was 165 lb. The parts shown on this page were blown 400 yd. from the river. Overpressure is the generally conceded cause of the explosion. The force of the explosion shattered the steamer and buried the bodies of the crew in the wreckage, the high and swift water making recovery difficult. A fusible plug in the boiler was sound and clean, indicating that low water was not the cause of the explosion.

Municipal Power Plant at Calgary, Canada--II

By A. G. Christie*

SYNOPSIS—Winter rates range from $20 to $26 per hp.-yr.; summer rates from $15 to $26 per hp.-yr. The load factor will determine whether the city or the Calgary Power Co. will profit by the arrangement that has been made for supplying electrical energy to the city.

In this second article dealing with the Calgary Power Plant some interesting figures are given regarding the rates charged and the expenditures of the electric-light and power department. On Dec. 1, 1913, the City of Calgary entered into a contract with the Calgary Power Co. for a supply of hydro-electric power at the following rates:

Winter Rates—First 5,000 hp., $26 per hp.-yr.; next 1,000 hp., $25; next 1,000 hp., $24; next 1,000 hp., $23; next 1,000 hp., $22; all over 10,000 hp., $20.

Summer Rates (April to October)—First 5,000 hp., $26 per hp.-yr.; all over this, $15 per hp.-yr.

The minimum load to be paid for is 5,000 hp. at $26 per hp.-yr., whether used or not. At the time the contract was signed, 8,000 hp. was the maximum amount that the company would undertake to deliver.

The basis of charge per month is on a maximum 30-min. peak load during this month, as shown by recording instruments in the Calgary Power Co.'s terminal station.

As long as the power factor on the city's supply does not go below 90 per cent., the actual power factor is used in figuring the power supplied. When the power factor does drop below 90 per cent., the factor 0.9 is used, even though the power factor is only 80 per cent. Every means is therefore employed to provide as high a power factor as possible. Hence synchronous motors are used on all motor-generator sets in the substations, and by this means the power factor is usually maintained between 0.9 and 1.0.

Until this summer the methods of operating were in general as follows: In winter the Calgary Power Co. was allowed to take 5,000 hp. of load, while the balance was supplied by the steam plant. At periods of low load the total power demand would drop below 5,000 hp. Besides it was hard to keep the hydro-electric load exactly at 5,000 hp. Hence the load factor on the supply from the Calgary Power Co. was usually about 0.9. The load on the hydro-electric system was regulated by adjusting the governors on the turbines in the steam plant.

During the summer the Galgary Power Co. is allowed to take the entire load and only certain gas-fired boilers are kept under steam for emergency use. The cost of labor, maintenance and supplies is reduced somewhat under these conditions.

In May, 1915, an agreement for one year was made between the city and the Calgary Power Co., in which the latter agrees to furnish the city with all the power that it requires at the rates already quoted. The city is to maintain an operating force at its steam-power plant under the supervision of the city's officials. But this plant is to be placed at the disposal of the Calgary Power Co. as a reserve station. The power company can call for power to any amount at any time and this is to be supplied to them. In return the power company assumes the cost of labor, fuel, supplies, repairs and ordinary maintenance, but it does not assume any capital charges on the plant. It is an interesting problem to figure out whether the Calgary Power Co. or the city will make money by this plan. It seems largely a question of load factor. If the winter load factor falls much below 0.6, the company will probably gain. If, however, it is above 0.6, it would seem that the city will profit by this scheme.

One favorable feature of the city's service is its high load factor. "Load factor" is defined as the ratio of average daily load to peak load. This in the past has averaged about 0.6. It is due principally to the following factors:

To a large all-night lighting load; to the pumping of water to reservoirs by motor-driven pumps in off-peak hours; to some large factories that run all night; to the night storing of batteries for electric-driven vehicles; a considerable portion of the down-town commercial lighting is handled by a private company, and this considerably reduces the winter lighting peak; the use of natural gas in residences for lighting also reduces the lighting load, which usually causes the high peaks in the load curve.

TABLE 1. EXPENDITURES OF ELECTRIC LIGHT AND POWER DEPARTMENT, 1914

Power Plant:		
Repairs to buildings and equipment	$11,732.84	
Fuel	48,735.17	
Superintendence	4,859.29	
Engine and boiler-room labor	32,056.20	
Water, oil, grease, waste, etc.	5,048.00	
		$102,431.40
General expense, salaries, taxes, insurance, etc.		11,146.50
Debenture interest		39,119.65
Sinking funds		14,926.00
Depreciation		17,411.32
Total power plant		$185,034.87
Lighting Section:		
Purchased hydro-electric power	$150,821.63	
Maintenance and repairs on lines, meters, arc lights, substations and conduits	78,894.34	
Engineering and superintendence	1,754.55	
General expense, salaries, taxes, insurance, rent of conduit, etc.	69,894.34	
Debenture interest	54,220.32	
Sinking funds	20,686.94	
Depreciation	3,113.97	
Meter depreciation	15,600.00	
Bad debts	12,633.32	
Total lighting section		407,619.41
Total electric light and power department		$592,654.28
Surplus, $77,857.96.		
Cost per kw-hr. supplied, 1.887c.		
Revenue per kw-hr supplied, 2.136c.		

In 1914 the city purchased 26,463,032-kw.-hr. from the Calgary Power Co., at a cost of $150,821.63, and besides this there was generated 4,928,564-kw.-hr. in the steam plant. The total power supplied by the city was therefore 31,391,596-kw.-hr. On account of certain flat rates all the power was not metered at the customer's premises.

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Although the city purchases power on very favorable terms from the Calgary Power Co., the revenue from the electrical department must cover all capital charges on the steam reserve plant, such as interest, sinking fund and depreciation. These charges have a considerable influence on rates for light and power.

A statement of the expenses of the electrical power department, is given in Table 1. Since the output comes from two sources and is charged in different ways, no attempt has been made to analyze these costs on the basis of cost per kilowatt-hour, except in the case of net cost. The department has shown a surplus of revenue over expenses for several years.

Reduced Rates for Light and Power

As the surplus of the electrical power and light department for 1913 was $75,669.88 and for 1914, $77,857.96, the city council passed a by-law on Feb. 16, 1915, authorizing to be put in force on Mar. 1, 1915, greatly reduced rates for light and power. It is estimated that at the new rates the department will just about pay its way in 1915. The by-law specifies certain deposits to be made by customers when applying for service. Such deposits are reserves to cover defaults in payment of bills. The new rates are as follows:

Light Rates—For the first 1,000 kw.-hr., 5c. per kw.-hr.; all over 1,000 kw.-hr., 4c. per kw.-hr. A discount of 10 per cent. is allowed on all bills paid within 10 days from the date of the bill. Minimum monthly charges are made of 75c. for the first kilowatt of connected load and 50c. for each additional kilowatt.

Power Rates—For monthly consumption of from 1 to 750 kw.-hr., 2.0c. per kw.-hr.; 751 to 1,750 kw.-hr., 1.8c.; 1,751 to 3,500 kw.-hr., 1.6c.; 3,501 to 12,500 kw.-hr., 1.3c.; all over 12,500 kw.-hr., 1.1c. Favorable discounts are allowed for current used during off-peak hours, and special rates are quoted in some cases A minimum monthly charge is made of 50c. per horsepower of connected load.

Some flat rates are still in force for lighting and are charged at the rate of 50c. per month for each of the first twenty 16-cp. lamps and 40c. for each additional lamp of this size. However, the use of tungsten lamps and meters is largely superseding this method.

When considering these rates and also the total electrical load, it is well to keep in mind the fact that Calgary has an abundant supply of natural gas, which is sold for domestic use at 35c. per 1,000 cu.ft. and is largely used throughout the city for lighting as well as for cooking and house heating. This makes a considerable reduction in the city's electrical lighting load as compared with those cities without cheap gas.

The plans for the first section of the new steam power house were prepared by J. E. Child, at that time city engineer. Construction was carried out under the supervision of Superintendent J. F. McCall, who has had charge of the municipal plant since 1905. The second section of the plant was designed by R. A. Ross & Co., of Montreal. The light and power distribution system is under the direction of the city's electrical engineer, R. A. Brown.

The whole electrical department comes under the supervision of Commissioner A. G. Graves, who has held office since 1910 and has been able to carry out comprehensive plans for providing for future growth of the city.

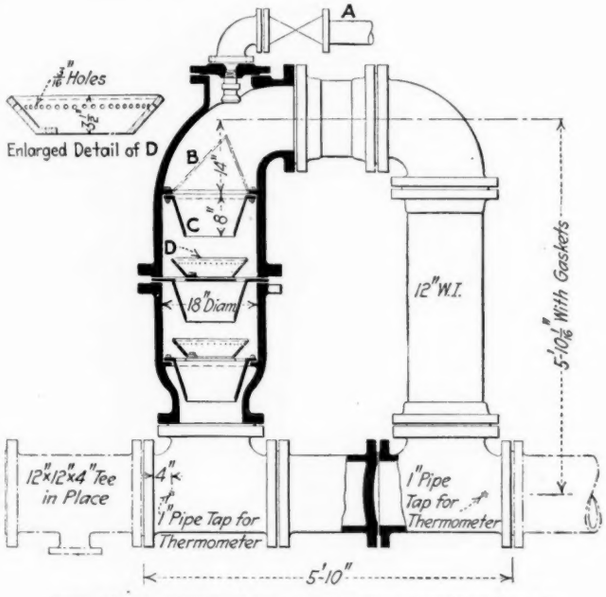
An Ammonia Jet Condenser

It is quite well established that the most efficient method of heat transmission is to get the maximum surface of condensing medium and bring the gas to be condensed into direct contact with that medium. The next best method is transmission through tubes, getting a maximum surface of cooling medium and of gas to make intimate contact with the tube. Velocity is important with this second method.

The jet principle of condensing has long been in use, but the writer does not know of anyone that has applied it to condensing ammonia gas from a refrigeration machine before its application as described herein.

The condenser in question is in the Sargents Wharf plant of the Quincy Market Cold Storage and Warehouse Co., Boston, Mass., and was designed and built by F. L. Fairbanks, chief engineer of the company.

Before its installation the ammonia gas was condensed by 20 shell-type condensers. The gas came into a header



JET CONDENSER FOR USE WITH AMMONIA GAS

from which branches led off to the condenser. A jet condenser has displaced most of those of the shell type, though a couple of them are used merely as auxiliaries.

As shown the gas comes to the condenser from the compressor and meets a film of anhydrous liquid ammonia pumped in through pipe *A*. To insure intimate contact of liquid and gas, both fall through the screen *B*, coming closely together again through the cone *C*, which directs liquid and gas into the inverted cone *D*, which is perforated with 3/8-in. holes around the periphery, causing finely divided streams to overflow. This construction applies also to the second-from-the-bottom cone. It is seen that whatever gas separates from the mixture dropping onto the cone must pass through liquid before it can enter the next directing cone.

Ordinarily the liquid and vapor leaving the jet condenser would be run through a simple double-pipe condenser to be finally cooled, but at the Sargents Wharf plant the shell-type condensers are used instead because they were already there when the jet condenser was installed. When used alone, the shell condensers are trans-

ferring heat from the gaseous ammonia to water, and the transfer from a gas to a liquid is never as efficient as from a liquid to a liquid. So the liquid and the little vapor with it that come from the jet condenser go to the vertical shell-type condensers, the liquid level being carried to the top of the tubes, or as nearly so as possible, the cooling water passing through the tubes, single-pass, counter-current fashion. The liquid and vapor ammonia enter the shell condenser tangentially, tending to give the liquid a whirling motion toward the bottom of the condenser, from which location the liquid anhydrous pump removes it.

A superheated gas is indeed a poor transmitter or absorber of heat when the heat must be taken through a medium such as tube surface, but when a superheated gas comes in direct contact with a cooler liquid, it immediately drops to the point of saturation and becomes a far better conductor of heat. This is what gives the jet-type condenser such an advantage, because there is no possibility of the superheated gas blanketing a tube through which the heat must pass, as in a tube condenser As the transmission of heat in the shell-type, or submerged, condenser is from liquid to liquid through tube surface, the two best-known methods of heat transmission are obtained by the combination.

The drawing needs some explanations: The lower end of the jet condenser, it will be noticed, is really a reducer fitting; the upper part of the condenser is a standard type of reducer elbow with outlet. By using these the expense of special patterns was saved. The joint in the middle permits of using cones of one size and of readily getting at any one of them. The outlet end of the elbow allows of making up the nozzle, flange and part of the liquid pipe before bolting.

With the anhydrous at 90 deg. F., as it is usually with water at 72 deg. F., there is a drop of from 160 to 175 deg. F. through the jet condenser. The principal dimensions are given, and the capacity is roughly 1,000 tons. F. L. Fairbanks, chief engineer of the plant, is the inventor

Goulds Oil-Pumping Units

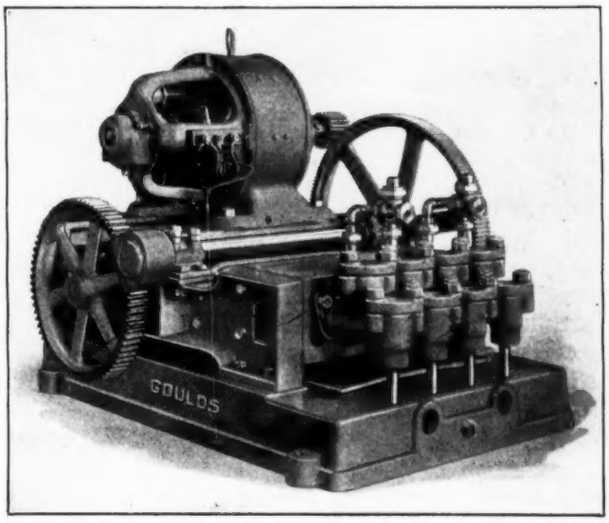
A motor-driven pump designed especially for forcing oil under the bearings of electrical machinery has been placed on the market by the Goulds Manufacturing Co., Seneca Falls, N. Y.

This pump, illustrated herewith, is of the single-acting quadruplex horizontal type with 7/8-in. cylinders and 4-in. stroke. It is designed for a capacity of 2 gal. per min. against a pressure of 1,200 lb. The base of the pump is built with a self-contained reservoir of 10 gal. capacity, to which the oil returns from the bearings. The pump has brass-lined cylinders, plungers of hardened tool steel, bronze crossheads running in bored guides, forged steel crankshaft and cast-steel connecting-rods babbitted on the crank end and bronze-bushed on the crosshead end.

At oil-tank stations where two or more kinds of oils are stored, a twin type of pump is used for transferring the oil from the tank cars to the storage tanks. The outfit consists of two 6x6-in. "Pyramid" single-cylinder single-acting piston pumps mounted on one base with pulley between. The shafts of both pumps are fitted with jaw clutches, so that the pumps may be operated separately or both at the same time.

As it is not always convenient to clean the pumps, this outfit permits of keeping the same pump for handling the same oil.

The company has also brought out a new air attachment for use with its deep-well working head, adapting



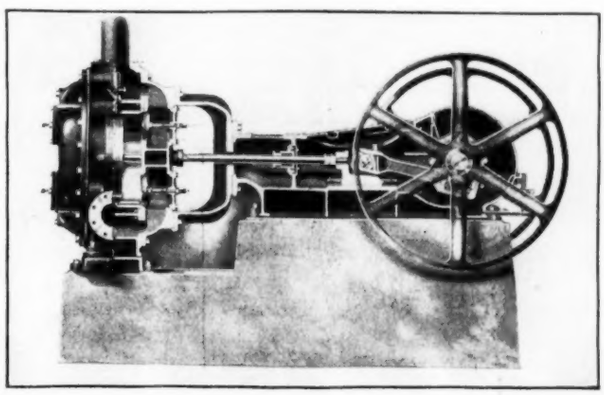
MOTOR-DRIVEN QUADRUPLEX OIL PUMP

this pump for use with pneumatic water-supply systems, also with elevated-tank systems. The attachment is made only for the smaller size of the pump, which has an adjustable stroke of 6, 8 and 10 in.

This device is mounted on the pump and consists of a brass cylinder with leather crimp-packed plunger and cast-iron operating yoke, bolted to the crosshead on the pump. The plunger of the air attachment should always be adjusted to suit the stroke of the pump; that is, if the latter is set for a stroke of 8 in., the attachment plunger should also be set for a stroke of 8 in. Two spacing pieces are furnished for this purpose and are all that is needed for making this adjustment.

Ingersoll-Rogler Vacuum Pump

The Ingersoll-Rand Co., 11 Broadway, New York, has recently placed on the market a new dry vacuum pump. The machine is of the horizontal, center-crank type and is built for both steam and power drive. The vacuum cylinders are fitted with "Ingersoll-Rogler" automatic valves. They are of the multiported plate type, afford ample port



SECTION THROUGH STEAM-DRIVEN VACUUM PUMP

opening with very slight lift and need no lubrication. The inlet valves are placed in the top and the discharge valves in the bottom of the cylinder heads, which construction provides for the immediate discharge of any liquid entering the cylinder. Both cylinder barrels and heads are jacketed to increase the efficiency by keeping down the heat generated in the vacuum cylinders.

The power-driven machine is furnished with a short-belted electric motor as a complete unit, as well as with plain belt wheel for other drive. The steam-driven type has a balanced piston steam valve to permit operation on steam that is supplied at high pressure and superheated. Because of the high operative speeds permissible with low-lift plate valves, the increased capacity of a pump of a given size in comparison with corresponding machines of the old type reduces the floor space required about two-thirds.

The vacuum pump ranges in capacity from 292 to 2,295 cu.ft. per min. and is guaranteed to maintain a vacuum of within one-half inch of barometer against a closed intake. The pump is also capable of handling discharge pressures of several pounds.

Controlling Large Motors

By Irwin B. Smith

SYNOPSIS—Instead of attempting to control the motor directly for such service as rolling mills, a motor-generator with a heavy flywheel is interposed, the flywheel carrying the peaks and the speed and direction of rotation of the mill motor being controlled by varying the strength and direction of the generator excitation.

The huge motors, ranging as high as 15,000 hp. capacity, that are used for driving reversing rolls in steel mills require the utmost delicacy of control. It must be possible to bring them quickly from rest to full speed, to vary their speed to any value within their range, stop them promptly and reverse them from full speed in one direction to full speed in the other within a few seconds.

These requirements obviously present some difficult problems. The ordinary rheostatic method of control, such as is used for small motors, is impractical for these giants. Even if the enormous currents at high voltages could be constantly broken with safety, the size of the controller and the resistance and the loss of energy in the resistance would be prohibitive. Furthermore, when one considers the voltage disturbance sometimes caused by the starting of a relatively small motor, it is evident that the continuous starting and reversing of these big machines would make even large generating systems useless for other services. Hence some different method of control must be employed.

These problems have been solved by the use of what is called an "equalizer flywheel motor-generator set." In this system the main alternating-current generator does not supply energy directly to the motor driving the rolls, but to the motor of a motor-generator set, consisting of an alternating-current motor, a direct-current generator, a heavy flywheel and a direct-current exciter, all mounted on a common shaft. The generator of this set supplies the current to the roll motor, which is, of course, also a direct-current machine.

Control of the roll motor is effected by varying the strength and direction of the field current of the direct-current generator, which is furnished by the exciter. If the field current of the generator is increased, the voltage of the current delivered to the roll motor also increases and the roll motor speeds up. Decreasing the field current has the opposite effect, and if the field current is reversed the roll motor reverses also. This field current is, of course, of insignificant strength as compared with that delivered to the roll motor, so that only a small rheostat is necessary.

The familiar principle of dynamic braking is used to stop the roll motor. If the generator field is so weakened that the voltage generated is less than that generated by the roll motor, the latter becomes a generator and attempts to drive the motor-generator set. This acts as

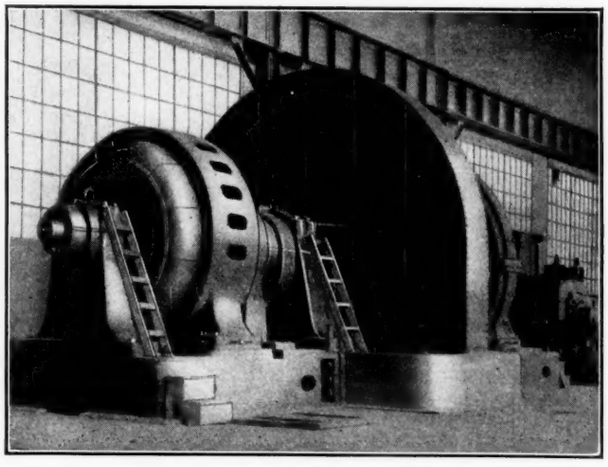


FIG. 1. FLYWHEEL MOTOR-GENERATOR SET

a powerful drag on the motor, and it promptly slows down without the application of mechanical brakes.

The part played by the flywheel is to prevent the heavy loads demanded by the roll motor in starting and reversing from being passed directly back to the main alternating-current generator, which is what would happen if the flywheel were omitted. It smoothes out these peaks in the following way: When the motor of the motor-generator set comes up to speed, it stores up energy in the flywheel, and when a heavy current is demanded by the roll motor, the motor of the motor-generator set is automatically slowed down somewhat by means of a "slip regulator," which will be described later. Since the driving motor slows down, the flywheel carries part of the load. When the peak load passes off the roll motor, the alternating-current motor speeds up again, restoring energy to the flywheel. Thus the load on the alternating-current motor is greater than that on the roll motor when the latter is lightly loaded, and less when the roll motor carries peak loads. So exactly can this regulation be

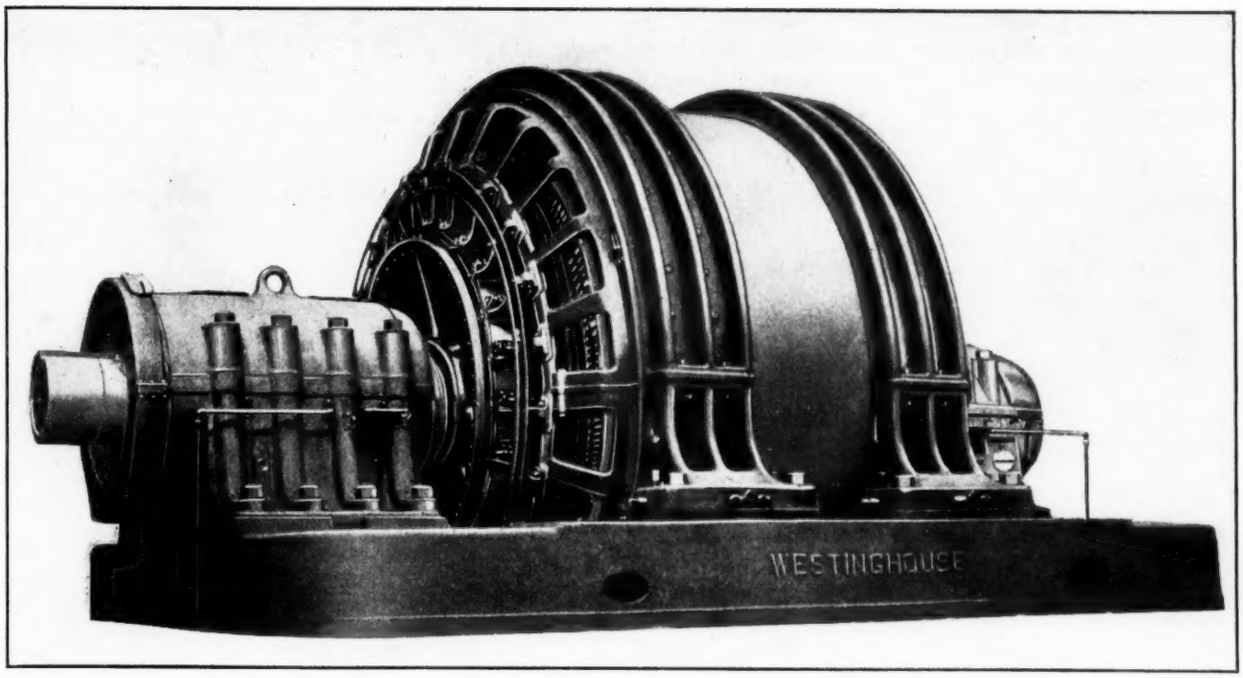


FIG. 2. 15,000-HP. DIRECT-CURRENT MOTOR-DRIVING REVERSING BLOOMING MILL

effected that the current delivered by the main generator can be kept practically constant, even though the power delivered by the roll motor is varying rapidly from nothing to perhaps 20,000 hp.

The diagram, Fig. 3, shows the connections for this system, the indicating and recording meters having been omitted for the sake of simplicity. The slip regulator consists of a liquid rheostat with three stationary electrodes connected to the three phases of the rotor of the alternating-current motor. Three movable electrodes are connected to an arm mounted on the shaft of a small torque motor, the other end of this arm being provided with a counterweight. This small motor receives current through a series transformer in the main line, as shown. When the current in this line increases, the motor pulls the electrodes apart, thus introducing resistance into the rotor circuit of the large alternating-current motor, reducing its speed and throwing the peak of the load on the flywheel. When the current in the line tends to fall, the motor moves the electrodes nearer together again, and the large alternating-current motor speeds up.

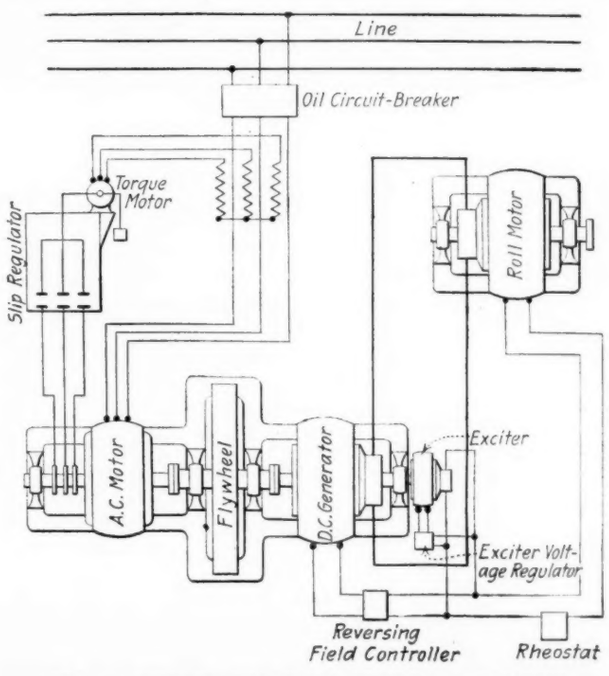


FIG. 3. WIRING DIAGRAM OF MOTOR CONTROL

Test of Seven Million Gallon Pumping Engine

At its Western Hills Station the Cincinnati Water-Works has recently completed the installation of a 7,000,000-gal. vertical triple-expansion high-service pumping engine. On Jan. 6 last the official duty and capacity trials were conducted. Following are the principal data of the test and an abstract of the report submitted by C. H. Anderson, superintendent of pumping for the city. During the trial Mr. Anderson was the city's representative and H. E. Gibbs represented the builder of the unit, the Holly Manufacturing Co., of Buffalo, N. Y.

The engine is of the vertical triple-expansion crank and flywheel condensing type, with self-contained pump ends of the direct-flow type. The city's specifications stipulated that the engine should be capable of delivering 7,000,000 U. S. gal. of water per day of 24 hr. operating against a net head of from 195 to 200 lb. per sq.in., when supplied with steam not to exceed 160 lb. pressure per sq.in. and 110 deg. of superheat at the throttle valve; and when operating at a piston speed not to exceed 215 ft. per min. Further city requirements were that the engine should be capable of developing a duty based on plunger displacement of not less than 185,000,000 ft.-lb. for each 1,000 lb. of superheated steam used by the engine and any auxiliaries supplied by the contractor and operated during the duty trial, when operating at its rated capacity against a total net head of from 195 to 200 lb. per sq.in.

with the steam pressure and superheat already cited. The contractor guaranteed the engine to be capable of developing a duty of 190,000,000 ft.-lb. under the stipulated operating conditions.

During the trial the revolution counter, water- and suction-pressure gages, steam, receiver, jacket and vacuum gages, temperature of condensation, steam, air and water were read regularly every 15 min. The overflow water, or discharge of the air pump, was weighed regularly at intervals of 15 min. The condensation from the first and second receivers and jackets was weighed every 30 min.

In the table are given the general dimensions, averages and totals of observed data, together with calculated data, incidental to the performance of the engine and general results of the trial:

RESULTS FROM OFFICIAL DUTY AND CAPACITY TRIAL OF PUMPING ENGINE

General Dimensions	
High-pressure cylinder diameter, in.	25
Intermediate-pressure cylinder diameter, in.	48
Low-pressure cylinder diameter, in.	72
Plungers (three), single-acting, outside-packed plungers, diameter, in	19½
Stroke of steam pistons and pump plungers, in.	42
Flywheels (two), diameter, ft.	14.6
Flywheels, weight each, tons	19
Surface condenser (one), location	Main suction
Surface condenser, cooling surface, sq.ft.	900
Exhaust feed-water heater, heating surface, sq.ft.	200
Air pump attached, combination wet and dry, in.	18x42
Feed pump attached, single-acting, in.	2¼x42
Air compressor attached, two-stage, in.	3x42

General Averages	
Date of trial	Jan. 6, 1916
Duration of trial, hr.	12
Average revolutions per minute	30.862
Average piston speed per minute, ft.	216.03
Average steam pressure at throttle, lb.	160.40
Average pressure, first receiver, lb.	25.49
Average pressure, second receiver, lb. abs.	13.03
Average jacket pressure, high-pressure cylinder, lb.	160.40
Average jacket pressure, intermediate-pressure cylinder, lb.	27.87
Average jacket pressure, low-pressure cylinder, lb.	3.68
Average vacuum, mercury gage, in.	28.82
Average barometer, in.	29.68
Average water pressure by gage, lb.	233.94
Average suction pressure by gage, lb.	36.22
Average net head pumped against, lb.	197.72
Average net head pumped against, ft.	456.34

Average temperatures, Deg. F.	
Air in engine room	71.50
Water pumped	40.00
Condensation, first receiver	268.29
Condensation, second receiver	204.89
Condensation, jacket	189.20
Discharge of air pump	50.00
Exhaust steam above heater	89.61
Feed water into exhaust heater	43.28
Feed water out of exhaust heater	71.32
Steam at observed pressure boiler gage	375.50
Superheated steam at boilers	509.10
Degree of superheat at boilers	133.60
Steam at observed pressure, engine gage	370.80
Superheated steam near engine recording thermometer	484.98
Average degree of superheat	114.18
Superheat steam near throttle of engine, mer. ther.	472.83
Average degree of superheat at throttle	102.03
Loss of superheat between boiler and engine, rec. gage	24.12
Loss of superheat between boiler and engine, mer. ther.	36.27

Total Steam Used	
Total overflow water weighed, lb.	65,451
Total condensation weighed from first receiver, lb.	1,121
Total condensation weighed from second receiver, lb.	2,519
Total jacket water weighed, lb.	2,345
Total water weighed from engine, lb.	71,436
Average overflow water per hr., lb.	5,454.25
Average water from first receiver per hr., lb.	93.42
Average water from second receiver per hr., lb.	209.91
Average water from jackets per hr., lb.	195.42
Average total water weighed or steam used per hr., lb.	5,953
Percentage of jacket steam	3.28
Percentage of condensation, first receiver	1.57
Percentage of condensation, second receiver	3.53
Percentage of overflow water	91.62

Capacity	
Total plunger displacement 24 hr. at contract speed of 215 ft., or 30.71 r.p.m., U. S. gal.	7,204,766
Total water pumped during 12 hr., plunger displacement, U. S. gal.	3,619,801
Equivalent, 24 hr., U. S. gal.	7,239,602

Duty	
Guaranteed duty per 1,000 lb. of superheated steam, ft.-lb.	190,000,000
Duty developed by engine per 1,000 lb. of superheated steam, ft.-lb.	192,851,062
Excess of duty over guarantee, ft.-lb.	2,851,062

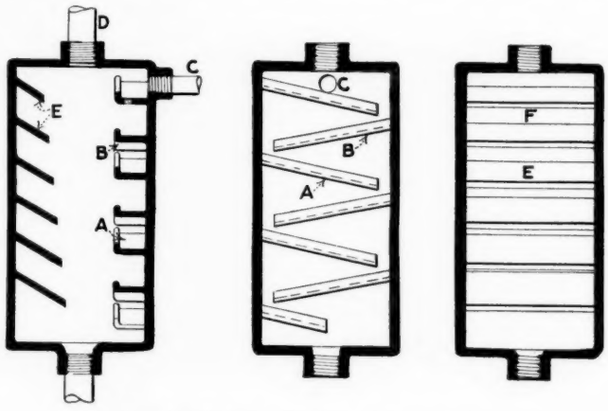
Heat Consumption and Efficiency	
Total B.t.u. delivered to engine per hour	7,469,586.28
Rejected B.t.u. overflow water per hour	98,176.50
Rejected B.t.u. first receiver per hour	22,168.57
Rejected B.t.u. second receiver per hour	36,484.46
Rejected B.t.u. jacket water per hour	20,843.14
Total rejected heat per hour	177,672.67
Net B.t.u. consumed by engine	7,291,913.61
Duty per million B.t.u.	157,440,773
B.t.u. per pump horsepower per minute	207.50
B.t.u. per indicated horsepower per minute	201.27
Thermodynamic efficiency, per pump horsepower, per cent.	20.44
Thermodynamic efficiency, indicated horsepower, per cent.	21.07
Calculated pump horsepower due pressure + 2 lb. friction loss into and out of pumps, condenser, etc.	585.7
Calculated steam end horsepower assuming 97 per cent. mechanical efficiency	603.8
Steam consumed per hour per pump horsepower, lb.	10.16
Steam consumed per hour per indicated horsepower, lb.	9.85

It will be noticed from the foregoing that the results obtained both as to capacity and duty all exceed the contract requirements. They are exceptionally good under the existing conditions of steam pressure and superheat.

Schneider Oil Vaporizer

The object of the Schneider oil vaporizer is to atomize cylinder oil to be carried in suspension in the steam to the valves and piston of an engine.

The vaporizer comprises a casing which is connected in the steam line to the engine. On the inside of this casing



DETAILS OF THE OIL VAPORIZER

are trays inclined at reverse angles as shown at *A* and *B*. They are staggered so that oil deposited in the top one gradually flows from one tray to another before reaching the bottom of the casing.

The oil is admitted through the connection *C* to the top tray. As steam enters through the pipe *D*, it impinges the oil upon the trays *A* and *B* and also upon the trays and deflectors *E*, which vary in length so that steam may, in striking each, be directed toward the inclined trays *A* and *B*.

By contact with the lubricant in the trays the steam becomes saturated with it, and the oil is carried in suspension to the parts to be lubricated. This action continues as long as steam and oil are admitted to the vaporizer.

This device is patented by F. W. Schneider, Clay Center, Ohio.

To Build a New Fire with a minimum of smoke when bituminous, high-volatile coal is used, put a thin layer, say 2 in., of green coal on the grate and cover with shavings and wood soaked in crude oil or its heavy distillates. Ignite and put on as little green fuel as possible, the aim being to begin the fire by burning the top of the layer, thus making the volatile gases and vapors pass through the hottest zone; keep the fire-door open as much as needed to prevent smoke.

Electric Load and Output in Large Cities

In the course of a recent investigation made by H. E. M. Kensit, of the Dominion Water Power Branch, in connection with power questions in western Canada, a very interesting table was prepared showing the per capita consumption of power in Greater Winnipeg as compared with a few other large cities in Canada and several in the United States.

The necessary data were collected from official sources, special care being taken that all sources of supply within a given city and district, including that for street railways, were incorporated. It should be added that this is not a selected list. Inquiries were made from a considerably larger list, and all cities have been included from which the returns received were sufficiently complete and definite.

The most striking point in the table is probably the high per capita position taken by Greater Winnipeg as a user of electric power. This is probably mainly accounted for by the extremely low cost of electric light and power in Winnipeg and district and the high cost of coal and gas in that district.

Where the price of electric light and power is as high as it is in most American cities and coal is cheap, or comparatively cheap, it means that there will be extensive use of gas and other illuminants and that many private fuel plants will be maintained for the production of power, so that the central-station load is smaller than it would otherwise be.

The table is presented herewith, and the data compiled are considered to form a valuable addition to the available sources of information on power consumption. For its use we are indebted to J. B. Challies, superintendent of the Dominion Water Power Branch, Department of the Interior, Canada.

Temperature Variations in the Turbine Steam Plant

Several months ago an insert was published showing a sectional view of a reciprocating steam plant in which the temperature drop of the steam and gases in passing through the various stages of the plant was given. An insert of similar order accompanies this issue, showing in section a turbine plant equipped with the regulation apparatus found in that type of plant.

Starting at the furnace an average temperature of 2,500 deg. F. is assumed, which drops to 1,500 at the left of the superheater, the gases going to the second pass at 1,360 deg., where more heat is absorbed by the boiler. The gas temperature going to the last pass is 800 deg., and it drops to 480 when leaving the boiler. At the economizer the temperature of the gases is 460, and 300 deg. in the chimney. This represents a drop of 2,200 deg. in passing from the furnace to the chimney. Saturated steam at 190 lb. abs. has a temperature of 378 deg. It is assumed that steam at this temperature is used with the auxiliary units. Between the boiler and the pumps the drop will be about two or three degrees, giving a temperature of 375 or 376 deg. The exhaust steam from the pumps, etc., will be at about 219 deg., and after passing through the open heater it goes to the atmosphere at 212 deg.

The main turbine requires a temperature higher than 378 deg. A superheat of 150 deg. is added to the saturated steam in passing through the superheater, giving the discharging steam a temperature of 528 deg. Allowing a drop of 28 deg. between the superheater and the turbine, the temperature will be 500 at the first stage, dropping 100 deg. for each stage and finally exhausting to the condenser at 100 deg. The condensation of the steam brings the hotwell temperature down to 90 deg., a drop of 438 deg. between the superheater and the hotwell.

ELECTRIC CENTRAL-STATION LOAD AND OUTPUT IN TWENTY CITIES, FOR THE YEAR 1914

A	B	C	D	E		F		G		H
		Population		Connected Load in Kw.		Peak Load in Kw.		Output in Kw.-Hr. Generated		
	United States	Census 1910	Estimated 1914	Total	Per Cap.	Total	Per Cap.	Total	Per Cap.	Figures Include
1	Atlanta, Ga.	154,839	199,740	88,000	0.440	44,320	0.222	145,684,803	730	Georgia Railway and Power Co.
2	Buffalo, N. Y.	423,715	457,900	137,872	0.310	67,424	0.147	302,220,107	660	Buffalo General Electric Co. and Cataract Power and Conduit Co.
3	Chicago, Ill.	2,185,283	2,436,000	852,000	0.350	344,500	0.142	1,280,962,600	527	Commonwealth Edison Co., St. Railway Co.'s and Sanitary District.
4	Columbus, Ohio	181,548	213,900	49,309	0.230	19,471	0.091	70,283,250	329	Columbus Railway, P. and L. Co. and Municipal Dept.
5	Detroit, Mich.	465,766	583,000	.....	.....	87,800	0.150	329,395,900	565	Edison Ill'g Co. and Municipal Dept.
6	Louisville, Ky.	223,928	232,350	97,000	0.417	28,200	0.122	100,692,219	433	Louisville Gas and Electric Co. and St. Railways.
7	Milwaukee, Wis.	373,857	420,000	.....	.....	46,924	0.112	170,889,000	406	Wisconsin Edison Co. and Commonwealth Power Co.
8	Minneapolis and St. Paul	516,152	601,900	144,778	0.240	91,655	0.152	270,168,475	450	Minneapolis General Electric Co., Consumers Power Co. and Twin City Rapid Transit Co.
9	Nashville and Chattanooga	154,968	179,590	60,843	0.338	20,200	0.113	71,401,500	398	Nashville Railway and Light Co.
10	Philadelphia	1,549,008	1,671,000	202,086	0.121	82,078	0.490	275,711,745	165	Phil. Electric Co. and St. Railways.
11	Pittsburgh	553,905	572,700	.....	.....	71,000	0.124	316,500,000	553	Duquesne Light Co. and Penn. Light and Power Co.
12	Portland, Ore.	207,214	314,000	.....	....	47,775	0.152	199,166,000	634	Portland Ry., L. and P. Co. and N. W. Electric Co.
13	Providence, R. I.	224,326	249,000	82,060	0.330	39,700	0.160	113,286,600	455	Narragansett Electric Light Co. and Rhode Island Co.
14	Rochester, N. Y.	218,149	248,000	68,177	0.274	29,813	0.120	123,850,785	500	Rochester Ry. and Light Co.
15	St. Louis, Mo.	687,029	740,400	.....	.....	92,176	0.125	319,151,753	430	Union Electric Light and Power Co., The Electric Co. of Missouri, United Rys. Co. and Laclede Gas Light Co.
16	Toledo, Ohio	168,497	187,250	60,315	0.322	23,965	0.128	91,996,426	491	Toledo Railways and Light Co.
	Canada	Census 1911								
17	Montreal, Que.	470,480	570,500	222,000	0.384	65,000	0.113	300,000,000	520	Montreal Light, Heat and Power Co.
18	Toronto, Ont.	376,538	468,000	178,677	0.382	64,064	0.137	250,240,500	535	Electric Light Co., St. Ry. Co. and Hydro-Electric System.
19	Vancouver, B. C.	100,401	186,400	61,290	0.330	34,300	0.184	124,884,565	668	B. C. Electric Traction Co.
20	Winnipeg, Man.	136,035	226,000	136,000	0.600	43,300	0.191	167,765,000	740	Winnipeg Elec. Ry. Co. and City Lt. and Power Dept.

The particulars given in the table were obtained by correspondence with the respective undertakings. Special care was taken to cover all sources of public electric supply for each city, including street and elevated railways. The figures are therefore believed to be substantially correct, but are given only as approximate, as the local conditions are not known in each case. The electric load and output cover the city and district in every case. The figures per capita cannot be exact, as the population in 1914 (*column D*) was estimated on the basis of the average annual increase shown by census returns for 1900 and 1910. In item 20 the population of Winnipeg in 1914 is estimated on the same basis as the other cities. The 1914 population was estimated for assessment purposes at 203,255, so that the figure taken (226,000) is unfavorable to the city. The population of Greater Winnipeg in 1914 is estimated by Henderson Directories, Ltd., at 276,177, but for the other cities only the population within the city limits is included and Winnipeg is therefore taken on the same basis.

Some of the heat of the exhaust steam from the auxiliaries is recovered, and a part of the hot gases discharged from the boilers is absorbed by the feed water. The boiler-feed water is taken by the pump at 90 deg. In the heater it is raised to 212 and in passing through the economizer is again increased to 250 deg., at which temperature it is discharged into the boiler.

The foregoing are approximate figures that would obtain in the average steam plant, with water-tube boilers, superheater, economizer and condensing turbine units, using saturated steam with the auxiliaries and superheated steam with the main turbine, at absolute pressures. The accompanying insert shows such an installation with the temperature of the steam and water designated at various points of the piping and in the steam units, also the temperature of the furnace gases during their passage through the boiler, then through the economizer and finally to the stack.

Tests of Hand-Fired Furnaces

By S. H. Viall

SYNOPSIS—Five series of tests to study the effect of arch construction on a hand-fired tubular boiler equipped with dutch-oven and flush-front furnaces. Properly proportioned arches for smoke reduction do not lower efficiency or capacity of boiler.

A few years ago firebrick-inclosed furnaces were considered the best and almost the only style of hand-fired furnace that could be used with high-volatile coals and have reasonably smokeless stacks. During 1908 a small meat-packing plant was built in which two 66-in. by 16-ft. return-tubular boilers were installed. The only fuel available was a high-volatile coal. There was a city smoke ordinance with which the owners desired to comply. After inquiry among neighboring plants using hand-fired boilers and consultation with authorities on furnace design, the owners decided to install full extension firebrick-inclosed furnaces, of the type commonly referred to as dutch ovens.

In the boiler room space was so limited that the extension furnaces occupied much of the area in front of the boilers. When cleaning the fires, the fireman often had to stand on the loose coal at the edge of the pile. The furnace was intensely hot, and in removing the tough stringy clinkers formed, the foreman's overalls were frequently burned. These disagreeable working conditions were tolerated for the sake of smoke abatement.

During 1913 a third return-tubular boiler, 60 in. by 16 ft., was installed. The furnace was made flush-front and of a type that had been developed since the plant was first built. Fig. 1 shows a plan of the boiler room.

The feature of the new furnace was the arch construction upon and to the rear of the bridge-wall. This construction had been used under hundreds of boilers, and there was no doubt that it gave better results from the smoke inspector's point of view than the dutch oven. The furnace temperatures were not as high, and there was clinker trouble because much of the refuse in the ash did not melt at the temperatures existing in the cooler furnace. It had been argued that the new furnace could not be as economical as older types of construction, as the arches insulated a part of the boiler shell from direct contact with the furnace gases, and the gases were directed downward toward the combustion-chamber floor immediately after passing over the bridge-wall. In the older types of furnace all of the heat-absorbing surface in the shell was exposed to the furnace gases, and with few exceptions the gases were directed against the shell.

After the packing plant had used No. 3 boiler for a few weeks, it was decided to replace the dutch oven with the new type of furnace. Engineers outside the plant learned of this decision, and to the owners they proposed running a series of tests to determine the relative efficiency and capacity of the two types of furnace with different arrangements of brickwork under the same return-tubular boiler. The necessary testing equipment was soon provided, and preliminary arrangements were made to allow normal operation of the plant without

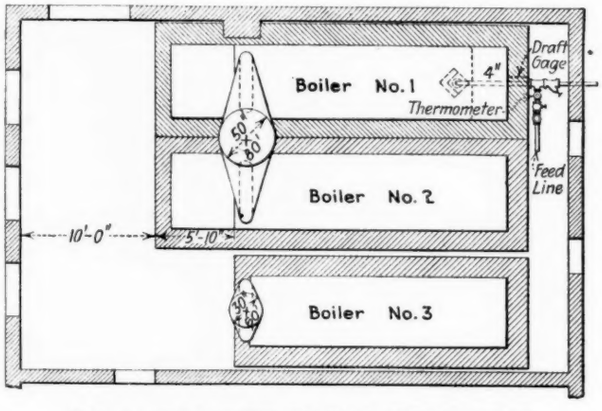


FIG. 1. PLAN VIEW OF THE BOILER ROOM

interfering with the testing apparatus. It was decided to limit each test to a run of six hours per day and to test the same equipment three days in succession, averaging the results. In all, 15 tests on five furnace constructions were made.

Details of the furnace constructions are shown in Figs. 2 to 6. A summary of the results of each test and the averages for the series are given in a table to the left of the drawing to which it refers. Details of the average results for each series are given in the accompanying table under headings A, B, C, D and E, which correspond respectively to the furnace constructions shown in Figs. 2 to 6.

The first series of tests was run without any changes in the construction of the furnace, which, as previously explained, was of the full extension firebrick-inclosed type with a two-span deflection arch behind the bridge-wall. The dutch oven extended 5 ft. 10 in. beyond the flue-cap doors. The boiler was set 4 ft. 1 in. above the dead-plate, as shown in Fig. 2. The grate, which was 5 ft. long by 5 ft. 6 in. wide, was made up of straight bars and had about 50 per cent. air space. The bridge-wall was directly below the front head of the boiler and

corbelled on the rear face at the top. Back of the bridge-wall 24 in. was a deflection arch 18 in. thick, built in two spans, each having a spring of 6 in. The center pier supporting the spans measured 9 in. on the face and 18 in. longitudinally. The top of the spring of the two openings under the deflection arch was 3 in. above the top of the bridge-wall and 3 ft. 6 in. above the combustion-chamber floor, the latter being paved with 4½ in. of firebrick. Above the deflection arch was a bulkhead of firebrick, 4½ in. thick, built close enough to the shell to prevent the gases from short-circuiting over the top of the deflection arch. Allowance was made for expansion without the brick touching the shell of the boiler.

The deflection arch to the rear of the bridge-wall was installed to reduce the smoke after the plant had been in operation a little over two years. It had been difficult to prevent puffs of black smoke, of from ½ to 2 min. duration, after each firing. For this purpose it was fairly successful.

During tests Nos. 2 and 3 of this series, the steam demand was not enough to permit forcing the boiler to the maximum. During test No. 1 the load was more than the boiler tested could continually carry, so that No. 3 boiler was used to help. It will be noticed that the combined efficiencies did not vary much for this series. Judging from No. 1 test, 110 to 115 hp. was about all that could be developed.

After the first series of tests the two-span deflection arch was knocked down, and the second, or "B," series was conducted with no other change in the furnace. During No. 4 test the load was not all the boiler could carry, but during tests Nos. 5 and 6 No. 3 boiler was used to help carry the load.

The dutch oven was then torn down and the furnace front moved back flush with the flue-cap doors. The side walls, which had been built perpendicular up to the

SERIES A

Test No.	Fire	Draft—Per Cent. Loss, A to B	Coal Fired per Sq.Ft. Grate, Lb.	Per Cent. CO_2	Horse-power	Combined Efficiency
1	0.132	68	24.85	9.2	110.9	49.5
2	0.105	69	21.22	8.5	92.2	50.5
3	0.110	72	21.82	9.1	96.0	50.7
Average	0.116	70	22.60	8.9	99.7	50 2

During Tests 2 and 3 unit was not worked to the limit on account of lack of load.

SERIES B

Test No.	Fire	Draft—Per Cent. Loss, A to B	Coal Fired per Sq.Ft. Grate, Lb.	Per Cent. CO_2	Horse-power	Combined Efficiency
4	0.108	81	21.13	7.8	102.8	53.6
5	0.110	81	25.47	10.7	132.6	60.4
6	0.120	69	27.27	9.6	141.6	58.5
Average	0.113	77	24.62	9.4	125.7	57.5

During Test 4 unit was not pushed to the limit on account of lack of load.

SERIES C

Test No.	Fire	Draft—Per Cent. Loss, A to B	Coal Fired per Sq.Ft. Grate, Lb.	Per Cent. CO_2	Horse-power	Combined Efficiency
7	0.200	64	24.4	9.6	125.9	52.4
8	0.220	54	23.5	8.8	123.9	51.9
9	0.230	52	26.1	9.3	141.3	57.3
Average	0.226	57	24.6	9.2	130.3	53.8

During Tests 7, 8 and 9 load was all unit could carry. Coal was uniform.

SERIES D

Test No.	Fire	Draft—Per Cent. Loss, A to B	Coal Fired per Sq.Ft. Grate, Lb.	Per Cent. CO_2	Horse-power	Combined Efficiency
10	0.219	54	25.6	9.0	130.0	52.2
11	0.230	53	26.7	9.4	138.7	55.5
12	0.230	55	22.2	8.9	126.7	57.5
Average	0.226	54	24.5	9.1	131.3	55.0

During Tests 10, 11 and 12 load was all unit could carry. Coal was uniform.

SERIES E

Test No.	Fire	Draft—Per Cent. Loss, A to B	Coal Fired per Sq.Ft. Grate, Lb.	Per Cent. CO_2	Horse-power	Combined Efficiency
13	0.250	55	24.4	9.0	135.5	57.7
14	0.240	54	28.9	8.2	154.4	55.4
15	0.210	56	25.3	10.3	128.8	51.6
Average	0.245	54.5	26.6	8.6	144.9	56 5

During Test 15 unit could not be pushed on account of lack of coal. Cleanings from storage had to be used. Plant was shut down for lack of fuel.

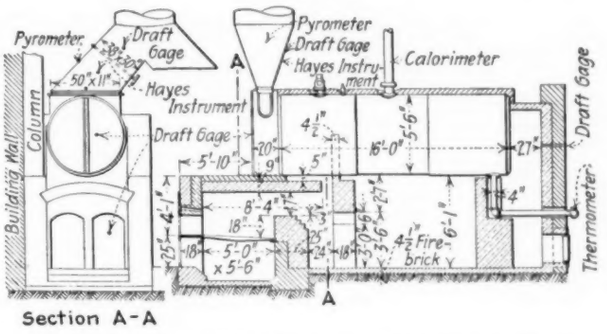


FIG. 2. FULL EXTENSION, TWO-SPAN DEFLECTION ARCH SETTING

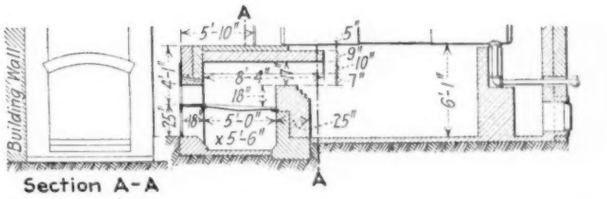


FIG. 3. SAME AS FIG. 2, BUT WITH DEFLECTION ARCH REMOVED

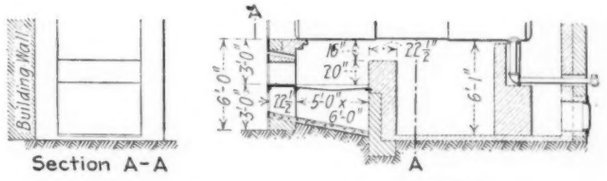


FIG. 4. PLAIN OR COMMON SETTING

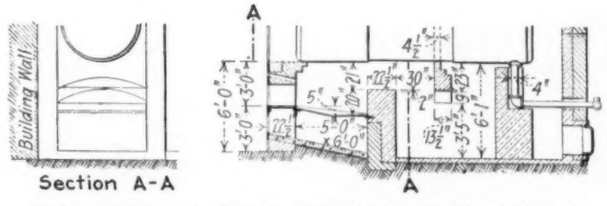


FIG. 5. PLAIN SETTING WITH DEFLECTION ARCH

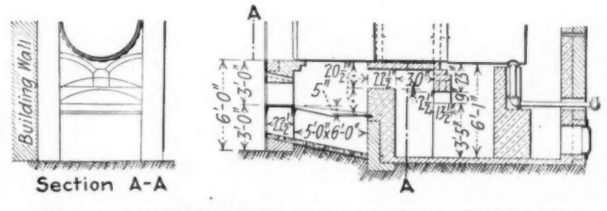


FIG. 6. DOUBLE-ARCH BRIDGE-WALL FURNACE

center line of the shell, were now set 3 in. farther out, giving a furnace 6 in. wider than the older one. Two plain grate bars were added to the old set to fill up the extra width.

When the fronts were moved back, the tops of the castings were cut off so as to raise the dead-plates to within 36 in. of the shell. At first, the grates were set level and a plain square bridge-wall was built up to within 16 in. of the shell, as shown in Fig. 4. The tests numbered 7, 8 and 9 were then run. During these tests the load was such that No. 3 boiler had to be used.

The results of this series upon the common setting, and of the two series following with arch construction added, are of especial interest. The greatest difference of opinion prevailed with reference to the effect upon the efficiency and capacity of adding arch construction to a common setting. With the plain setting, 130 hp. was developed at an efficiency of 53.8 per cent.

After the tests upon the plain setting, the grates were lowered 5 in. at the rear and 5 in. taken off the top of the bridge-wall. A single-span deflection arch 13½ in. thick was built 30 in. back of the bridge-wall, as shown in Fig. 5. The spring of the arch was 1½ in. to the foot of span. The top of the spring was 2 in. below the top of the bridge-wall, and 4½-in. bulkheads were built on top of the deflection arch to prevent the gases from following the boiler shell straight back. Throughout this series No. 3 boiler had to be used to help carry the load. With the deflection arch added to the plain setting, the average horsepower developed increased and the efficiency was 1.2 per cent. higher. Causing the gases to turn sharply downward after passing over the bridge-wall had not reduced the efficiency or the capacity, as many claimed it would.

Following this series a pier 13½ in. wide was built upon the center line of the setting. It extended from the front face of the deflection arch and at the top to the front face of the bridge-wall, rising about 15 in. above the latter. From the center pier to the side walls arches 4½ in. thick were sprung, as shown in Fig. 6. A better illustration of the furnace is shown in Fig. 7. The second bulkhead, added to prevent dust accumulations on top of the double arch, does not appear in the perspective view.

Upon the day of the third test of this series the coal supply ran out, and on this account it was decided to disregard this test and average the results from the other two tests of the series. These averages show 13 hp. more capacity and an increase of 1.5 per cent. in efficiency over the previous series, the results of which were better than for the common setting. It is of interest that covering 52 in. of the length of the shell did not cause a reduction in the capacity or efficiency of this boiler.

No. 1 boiler, one of two set in a battery connected by a pants breeching to a stack 50 in. above the grates, was used in the tests. Each boiler was 66 in. diameter, 16 ft. long and had fifty-four 4-in. tubes. The unit tested was pushed to the utmost capacity whenever conditions permitted. When the load was greater than one boiler could carry, the difference was made up from No. 3 boiler, which was in a different setting and on a different stack from the one under test. No. 2 boiler, being in the same battery and upon the same stack as No. 1, was not run during the tests nor for several hours before. The combustion chamber of the boiler under test was carefully cleaned, and the tubes were blown before starting a test.

Comparatively thin fires were carried during the first series, and the furnace doors were closed immediately after each firing. The apparent efficiencies during the series were so poor that the engineers gathering the data suggested that for the second series the fires be carried 2 or 3 in. thicker and that the fire-doors be left open a few inches for a minute or so after firing, to permit a comparatively large supply of air over the fire during the period of most rapid distillation of the volatile matter.

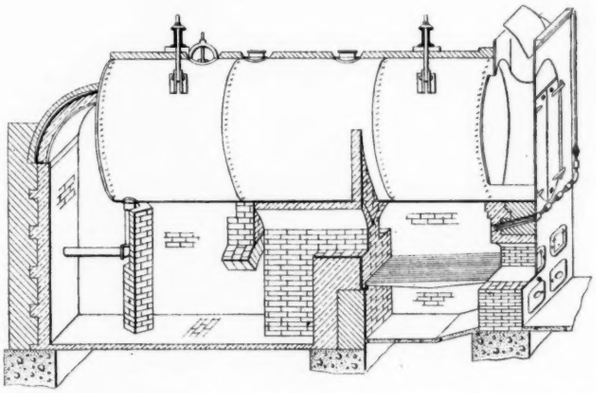


FIG. 7. PERSPECTIVE VIEW OF DOUBLE-ARCH BRIDGE-WALL FURNACE

The efficiency for this series was so much better that it was decided to make no suggestions as to the method of handling the fires during the following tests, so that conditions might be kept uniform.

With the exceptions mentioned, care was used not to influence the operation of the plant. It was known that the efficiency would be low unless greater skill than ordinarily found at the plant was used in handling the fires. It was desired to determine what could be expected of the equipment when operated under commercial conditions by a man having but little experience as a fireman—one of those men who keep up the steam pressure but give no thought to economy. Therefore the man at the plant was allowed to handle the fires in his own way.

RELATIVE EFFICIENCY AND CAPACITY OF FIVE HAND-FIRED FURNACES

Series	A	B	C	D	E
Type of furnace, Fig. Nos	2	3	4	5	6
Builders' rating, boiler, hp	100	100	100	100	100
Water-heating surface, sq.ft	1,043	1,043	1,043	1,043	1,043
Active grate area, sq.ft	27.5	27.5	30	30	30
Kind of coal	Indiana lump for all tests				
Moisture, per cent	15.4	16.3	10.1	11.3	10.9
Combustible, per cent	73.5	73.32	76.77	73.89	75.02
Ash, per cent	11.1	10.38	13.13	14.81	14.08
B.t.u. per lb. coal as fired	10,674	10,716	11,225	10,618	10,728
B.t.u. per lb. dry coal	12,620	12,809	12,486	11,966	12,041
Dry ashpit refuse, lb	313	323	622	623	626
Per cent. dry ashpit refuse to dry coal	9.89	9.45	15.96	15.76	14.65
Per cent. combustible in refuse to combustible supplied	2.64	2.46	3.46	4.42	4.94
Steam pressure, lb. gage	93.21	96.6	97.3	104.8	96.5
Temp. of feed water, deg. F	140.8	142.1	148.6	142.8	168.3
Quality of steam, per cent	96.23	96.53	96.59	96.93	97.36
Temp. in uptake, deg. F	611	672	665	678	681
Draft at damper (A), in. of water	0.379	0.51	0.50	0.49	0.535
Draft at flue cap, in	0.212	0.232	0.35	0.37	0.345
Draft at combustion chamber			0.24	0.23	0.268
Draft over fire (B)	0.116	0.113	0.22	0.226	0.245
Draft lost through boiler, per cent	70	77	57	54	54.5
Horsepower developed	99.7	125.7	130.4	131.8	144.9
Per cent. builders' rating	99	125	130	132	145
Equiv. evap. from and at 212 deg. F. per lb. of combustible, lb.	7.517	8.709	7.91	8.153	8.327
Efficiency of boiler and grate based on combustible supplied, per cent	50.2	57.5	53.9	55.1	56.5
CO_2, per cent	8.9	9.4	9.2	9.1	8.6
O, per cent	10.8	10.2	10.5	10.4	11.1
CO, per cent					
N, per cent	80.3	80.4	80.3	80.5	80.3

without special instruction as to the degree of care or attention he should exercise. The fireman was not informed of the purpose of the tests. In other words, the tests were made under as nearly normal conditions as possible, and the average results for a series are comparable one with the other. The results are typical of the operating efficiency of the great majority of small plants.

In each test the coal was carefully weighed, samples of coal and ash were analyzed, and the best instruments were used to get complete test data. The readings on all instruments were made at fifteen minute intervals.

Siphon steam jets were provided in the front of the furnace, but they were not used during the tests.

The tests show that arch constructions of correct proportions are not a detriment to efficiency or capacity. It was acknowledged that the double-arch bridge-wall furnace, shown in Figs. 6 and 7, was the best, for smoke prevention, of those tested.

A detailed study of the draft data of these tests will bring out some interesting points. A close analysis of the factors affecting the efficiencies will show some odd features. A discussion of these points will be presented at some future time.

Recording Instruments for the Boiler House

By F. J. Denk

A chief engineer or superintendent may point with pride to the top of his stack because not a trace of smoke is visible, and yet this smokeless condition may be obtained at a sacrifice of economy. If he is asked about the CO_2 in the flue gases or the amount of excess air, he replies: "I don't care so much about that; I want my stacks smokeless." Nevertheless these furnaces may be eating up coal by the ton, whereas excessive waste of fuel could be prevented by applying suitable methods and apparatus and without having smoking stacks.

Among the methods applied, the determination of the amount of carbon dioxide in the flue gas has been considered one of the most important. This determination shows, generally, whether combustion is taking place with the least wasteful amount of excess air. Several types of CO_2 indicators or recorders on the market will give reliable results when handled with proper care; otherwise they are likely to get out of order. This means extra work and may be neglected from day to day, until finally a valuable instrument is put out of commission by simple neglect.

It is not necessary, however, to have a continuous record of the amount of CO_2 in the flue gas, although it is well to have an occasional CO_2 determination to serve as a check. Instead of measuring the CO_2 content in the flue gases, which means measuring the product of good combustion, the conditions (draft) that lead to good combustion may be measured, for in order to burn economically a given amount of coal per hour a certain quantity of air is required. The amount of air varies, of course, with the quality of the coal, but after this quantity has once been determined by test for given conditions, it will always be possible to duplicate the results, when the furnaces are worked under the conditions that have been found during the test to be the most favorable by regulating the amount of air entering the combustion chamber. This regulation is possible for the reason that the volume of air going through the passages and the resistance against the flow of the air in the passages have a certain constant relation to each other, and by changing the position of the damper, one can regulate the difference in draft—that is, the velocity of the air going through the passages. In order to make the regulations or changes intelligently, it is necessary to know at every instant the draft in the combustion chamber and the difference in draft between the combustion chamber and breeching, as shown in Fig. 1. Therefore, with an instrument that continuously records these values, it is possible to regulate the draft and be sure of an economical working of the furnace.

Instruments of this type, based on the hydrostatic principle, that makes them very simple in design and operation, are on the market, known commercially as "Hydro Recorders."[1] Since there are practically no wearing parts, a long life is insured and they give good results.

There are three types of these instruments—the simple draft recorder, the differential draft recorder and a combination of the differential and simple recorders—all based on the same principle and built to serve their special purposes. For this reason, the description of one type—a differential draft recorder—is given, and the construction and design of the other two types can easily be understood from the illustrations.

The apparatus, Fig. 2, consists of a cylindrical vessel A, which is partly filled with water. Into this water dips another cylinder B, open at the bottom and closed at the top, which carries a float C, ordinarily of cylindrical shape and guided by the rod S. The interior of the vessel is made air-tight by a water-sealed cover D. Pipe E leads into the space above, and F into the space below the cylinder B. Each has a stopcock G connected by a lever H, which insures admission of the draft to both sides of the cylinder simultaneously. A connection to the atmosphere is made possible by a three-way cock I.

The action of the instrument is due to the difference in the pressure (draft) above and below the bell B, and the variation in this difference causes an up-and-down

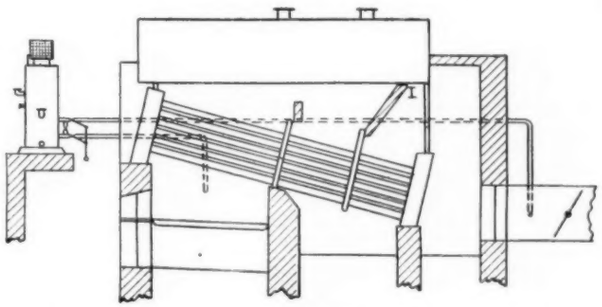


FIG. 1. MEASURING DIFFERENCE IN DRAFT

movement of cylinder B, which movement is transmitted to the outside recording drum M by a rod J inclosed in a tube K. This tube extends below the water level inside the apparatus, thus making an air-tight connection. A pen L attached to the top of the rod makes a graphic record on the paper wound around the recording drum M. Openings N and O represent necks for filling the different compartments with water, while P and R serve

[1] Manufactured by the Bacharach Instrument Co., Pittsburgh, Penn.

for draining them. Levers and stuffing-boxes, which may cause error and make the records unreliable, are avoided.

As before stated, the minimum air necessary for economical combustion varies with the kind of coal fired, and the position of the damper has to be determined by experiment. After this is once accomplished, this minimum should be adhered to as constantly as possible for the prevailing conditions, which may be done by watching the draft in the furnace and flue and noting the difference. For this purpose either one of the devices named may be applied, although neither the simple draft recorder nor the differential draft recorder alone give it for all conditions. For instance, the simple draft recorder, Fig. 3, gives only a record of the draft in one place (the combustion chamber or breeching), and this is not enough for the economical working of the furnace. The same holds good for the differential draft recorder, Fig. 2, but combining the records of both instruments or using a combination differential draft recorder, Fig. 4, that records simultaneously the draft in the combustion chamber and flue, the fireman is enabled to judge and regulate the air supply intelligently.

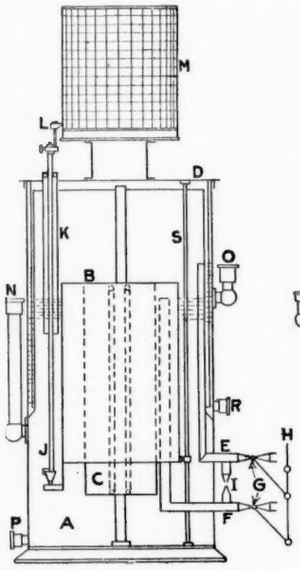


FIG. 2. DIFFERENTIAL DRAFT RECORDER

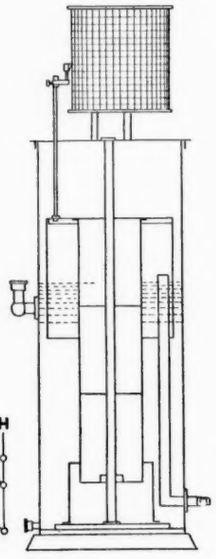


FIG. 3. SIMPLE DRAFT RECORDER

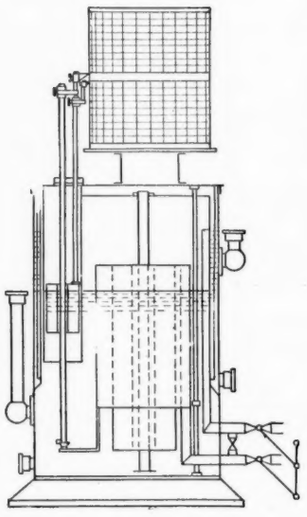


FIG. 4. COMBINATION OF FIGS. 2 AND 3

Fig. 6 shows an ideal diagram from such a recorder, illustrating the working of the instrument. It is assumed that the difference in draft between the combustion chamber and breeching has been found by test to be as shown at the left from *a* to *b*. This condition indicates, therefore, normal working of the boilers with the dampers in a certain position. Too much air is indicated by the portion between *b* and *c*, where the differential draft is above normal, while the combustion-chamber draft is below normal, owing to the following conditions:

If the fuel bed becomes thinner and less compact, more air will enter the combustion chamber; consequently the volume of gas increases. This causes a decrease in the draft at the grate and an increase in the difference in draft between the breeching and the combustion chamber. The former value would indicate an air relief at the grate, the latter a larger gas volume. But since a larger gas volume can be generated only by increasing the draft at the grate and at the breeching—assuming of course that the grate bars are covered evenly and that the combustion is steady—this condition shows that too much air is entering the combustion chamber. The larger amount of gas is only due to a larger amount of air entering through the grate bars and not to the combustion of a larger amount of coal, as might be assumed by considering the draft readings alone.

Lack of air is shown by the portion *c-d* of the diagram. The differential draft falls below normal and the draft goes above normal, for the following reasons: If the fuel bed becomes thicker and more compact, less air will enter the combustion chamber, the draft at the breeching of course not having been altered. The amount of gas generated will become smaller, which causes an increase in the draft above the grate and a decrease in the difference of the two drafts. The increase in the draft above the grate seems to indicate that there is a pressure at the grate higher than normal. The smaller differential draft, on the other hand, seems to show that a smaller volume of gas is going through the passages. The combination of the charts, however, shows that less air enters the combustion chamber than normal; that is, there is not enough air for complete combustion.

The conditions for overload and underload are illustrated in the portions *d-e* and *e-f* respectively. Overload is shown by both drafts being higher than normal, while underload is indicated by both drafts being lower than normal. Considering that overload is produced by firing more coal than under ordinary conditions and by opening the damper wider than normal and that for underload these conditions are reversed, the reasons for the action of the instrument in producing such a chart may be easily understood.

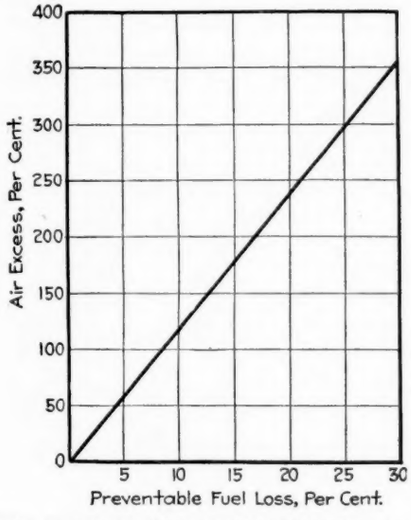
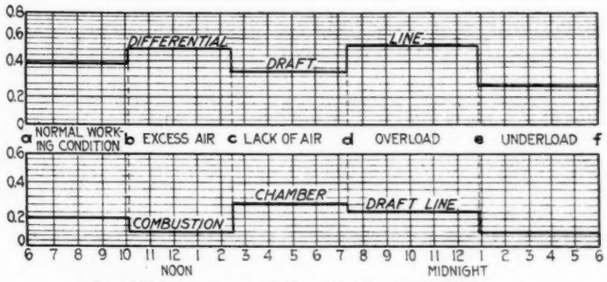


FIG. 5. FLUE LOSS FROM EXCESS AIR

Fig. 7 gives an actual diagram from a hydro differential draft recorder, which can be interpreted according to the foregoing explanation.

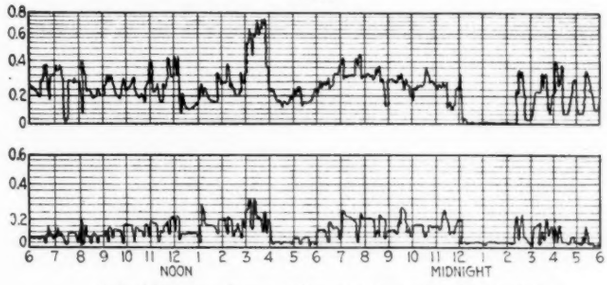
After the installation of the apparatus the minimum amount of air necessary for the economical operation of the boiler must, as before stated, be determined by tests, either by trial or by using an ordinary CO_2 apparatus, which gives a quick determination of the CO_2 content of the flue gases.

The trial is started with a strong draft, opening the damper wide, then gradually closing it, thus decreasing



Ideal Diagram from a Differential Draft-Draft Recorder

FIG.6



Actual Diagram from a Differential Draft-Draft Recorder

FIG.7

FIGS. 6 AND 7. DEPARTURE IN PRACTICE FROM IDEAL CONDITIONS

draft and differential draft until the most favorable conditions are arrived at. Considering those values to be the most favorable ones at which a certain predetermined quantity of steam can be generated with the least possible amount of fuel, these values can then be marked on the diagram sheet, as in Fig. 6 at the left (portion *a* and *b*) and this position should be kept as constant as possible for the kind of coal in use, unless special circumstances (overload, underload, etc.) warrant a deviation. Needless to say, the grate should be free from clinkers and ashes and the fuel bed evenly distributed over the whole grate.

A second method gives still better results. After the recorder has been installed and the Orsat apparatus—or whatever instrument for the determination of the CO_2 is to be used—is ready for action, the grate, which must be free from ashes and clinkers, is covered with a layer of fuel 5 in. thick, and the damper is opened wide. A determination of CO_2 will then be made, which in all probability will show too low a percentage. The opening of the damper is then decreased somewhat, and a new determination of CO_2 is made. If the decreased damper opening caused a drop in the steam pressure, it must be opened a little and the fuel bed made thicker. After a few such trials the most favorable conditions will be arrived at, and the corresponding drafts and differential drafts can then be marked on the diagram sheet to be used as a guide. They should, for the same grade of coal, be strictly adhered to except for special conditions, as before mentioned.

This method of boiler control has the advantages of low first cost of the instruments little likelihood of their getting out of order, little attention required—changing the diagram strips once a day and winding once a week the clockwork that revolves the paper drum. Considering the saving in the coal bill that may be effected through economical management of the boiler house in proportion to the small outlay for an installation of the kind, it is well justified. Fig. 5 shows the relation between the percentage of excess air and the percentage of preventable fuel loss.

Keeping Tabs on the Power-Plant Equipment

By W. Sailes

The first step in a complete power-plant record should be the identification of every piece of equipment in the plant, and the establishing of a record of its cost, upkeep, performance, etc., thereby simplifying the matter of keeping a schedule of the present valuation, condition, capacity and cost of upkeep of each particular machine. This system of identification also prevents confusion when giving instructions concerning any particular piece of equipment.

One of the best methods is to classify all power-plant apparatus into, say, three main groups: (1) Steam Generating; (2) Power Generating; (3) General Maintenance. Each of these main groups should be designated

CLASS AND NUMBER ..... Location .....
Service ..... Method of Operation .....
Special Data:

Maker ..... Purchased through .....
Our Pur Order ..... Price delivered .....
Mfrs. Shop Order ..... Cost of installation .....
Mfrs. Serial Number ..... Price installed .....
Cost accessories installed .....
Mfrs. Blueprint .....
Our installing drawing ..... Date installed complete .....
Illustration .....
List of Repair Parts File .....
Nearest House carrying complete repair parts .....
Extra parts carried in our stock. Where .....

STANDARD PERFORMANCE GUARANTEES:

Accessories.

Kind	Pur'd. from	P.O. and Date	Installed	Cost	Installation	Total Cost

FIG. 1. CARD NO. 1, RECORD OF INDIVIDUAL EQUIPMENT

by letter, and then each individual machine in the group should carry its own particular designating letter and number. For instance the subdivision might be made as follows:

STEAM-GENERATING EQUIPMENT, "S"

Boilers	B	Economizer	HE
Stokers	S	Water Meter	WM
Blower Equipment	D	Boiler-Feed Pumps	FP
Coal and Ash Equip.	A	Water Softener	W
Coal Weigher	CW	Steam Meter	SM
Ash Weigher	AW	Gas-Analysis Outfit	GM
Feed-Water Heater	H		

POWER-GENERATING EQUIPMENT, "P"

Turbines	T	Condensers	C
Engines	E	Condenser Air Pumps	CPA
Generators	G	Condenser Water Pumps	CPW
Exciters	GE	Condenser Circ. Pumps	CPC

GENERAL MAINTENANCE, "M"

Cranes	CH	Air Compressors	AC
Fire Pumps	FP	Elevator Pumps	PE

In a plant having eight boilers, the designation would be Sb-1 to Sb-8. If there were three turbines the designation would be Pt-1 to Pt-3. Cranes would be designated as Mch-1, etc.

Wherever possible a standard form of lettering, as well as color, should be used, the group designation being pref-

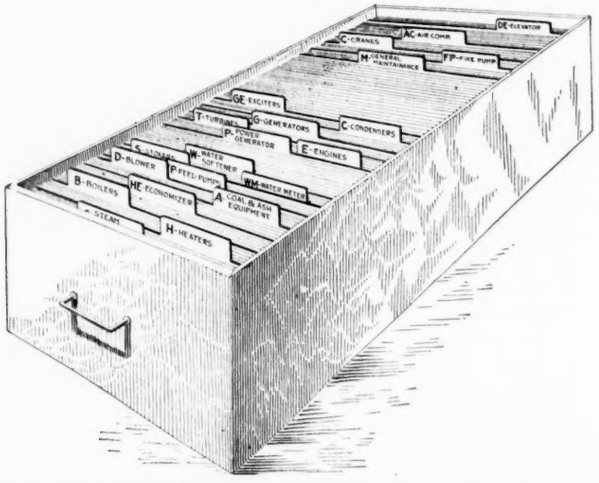


FIG. 3. METHOD OF INDEXING AND FILING CARDS

erably slightly larger than the subdivision designation, and this should be painted prominently on each piece of equipment. A complete schedule of these designations,

Record of Repairs, Inspections, etc.			Class and No.
Date	Report of Details	New Parts or Material Used	Total Cost

Inventory Value		1915	1916	1917	1918	1919	1920	1921	1922	1923
	Initial Cost									
	Main Unit ($)									
	Accessories ($)									
	Total Valuation									

Notes:

FIG. 2. CARD NO. 2, REVERSE OF NO. 1, RECORD OF REPAIRS

with a brief description of the equipment to which they apply, should be posted at convenient points.

Then the next step is to keep a record, preferably on indexed cards, of each particular piece of equipment, giving details as to the location, type, make, value, standard performance, upkeep costs, etc., as shown in card, Fig. 1.

This card is intended to give all the data necessary concerning the apparatus in question, such as is valuable in case of a breakdown requiring ready reference to repair lists, etc. Data as to the capacity, steam consumption, working pressures, load factors, size connections, etc., should be given under the heading, "Special Data."

The reverse side (Fig. 2) of the card should give a complete record of the work that has been done on the machine, the cost of repairs, upkeep, etc., and a section is also provided for establishing the present-day value of each machine for use when taking the yearly inventory.

The blueprints, catalogs, repair lists, etc., for each machine should be kept in a file near the card file, or the forms can be printed on the outside of good stiff envelopes of the proper size and all the information filed away together; that is, the record data on the outside of the envelope and the blueprints and catalogs on the inside.

For purposes of identification the color of the cards for each main group should be different. For instance, a light-red card could be used for the "S" group, a light-green card for the "P" group, and a light-yellow card for the "M" group. In filing and fixing the various designating numbers, a sufficient supply of blanks should be inserted to take care of future additions and replacements. An outline of the method of filing is given in Fig. 3.

Sawmill Boiler Exploded

A 60-hp. submerged-tube-sheet upright boiler at the sawmill of the Shenango Furnace Co., about eight miles north of Ligonier, Westmoreland County, Penn., exploded Wednesday afternoon, Jan. 26, 1916, severely injuring

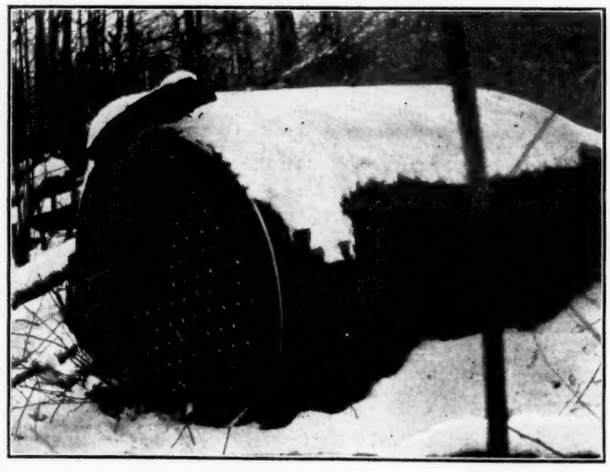


FIG. 1. SHELL OF THE EXPLODED BOILER

four men who were working near-by. Not a stick of the timbers which formed the boiler house was left standing. A heavy fall of snow shortly after the explosion interfered with the photographer, making it impossible to show clearly the damage done.

The main part of the shell, Figs. 1 and 2, was thrown about 500 ft. to the south and landed on a hillside in the woods. Another section, shown in Fig. 3, was stopped by a tree about 75 ft. from its original location. This piece was torn along the lap seam (single-riveted) for about 3 ft., but the material seemed to be free from flaws. The top sheet, Fig. 4, was blown over 200 ft. in a northwesterly direction. The plates were not corroded or pitted,

FIG. 2. ANOTHER VIEW OF BOILER SHELL

FIG. 3. PART OF FURNACE

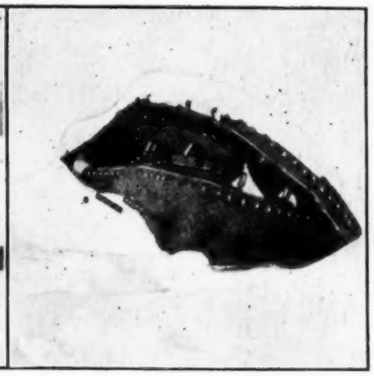


FIG. 4. SECTION OF TOP SHEET

the bolts and rivets were in good condition and there was no scale on any part of the boiler. The engine was completely wrecked and lies upside down about 20 ft. from its foundation.

No one seems to know what caused the explosion, the engineer stating that he had 80 lb. steam pressure and two gages of water. No boiler inspection is required by law, and it is not necessary for an engineer to hold a license to operate a plant in this locality. However, the condition of the boiler and connections after the accident would indicate that it was in good condition. It is believed locally that the explosion was caused by suddenly injecting cold water into the boiler when the water was too low, but it is difficult to reconcile this theory with this type of boiler. The pressure usually carried was 100 lb.

Lodge-Room Engineering--I

By W. O. Rogers

SYNOPSIS—Casey, a fireman, believes in the old-fashioned wheelbarrow as a coal conveyor and a good man to push it. A discussion both for and against the economy of coal-conveyor systems follows his remarks.

Not every engineering society has taken up the educational work in the most practical manner, and if one should happen to drop into an engineers' meeting after the routine business has been disposed of, the free-for-all discussion would be both amusing and instructive, especially in some of the smaller gatherings. Generally one of the brighter lights will introduce a subject, which will at once be seized upon as an appetizing morsel for discussion, and then the presiding officer will sit back and allow matters to take their course, beyond limiting one speaker to the floor at one time.

Among the members that generally have the most to say in the particular organization that I have in mind was a chief engineer, Robert Johnson, called "Dad" for short; his oiler, Gus Semple; a fireman, Mike Casey; Tom Miller, an engineer from the flouring mill and called "Dusty"; Joe Sumers, engineer at a shoe shop; Jake Grumbling, usually called "Grumps" for short; Royal Winters, an engineer in a near-by tannery; and George Myers.

Gus Semple was a progressive young fellow always after information, hence his popularity with his chief. Casey was a typical Irishman who would never get any farther than the fireroom, but once when he ran a small engine for a time he joined the association, where he still held his membership. He had no desire to go higher, his ambition being satisfied when he got a good job with not too much to do, which was the condition at his present plant. "Dusty" Miller was just an ordinary engineer who took things as he found them and made the best of life with the least trouble possible. In this way he never had any troubles and never got very high as an engineer. Dad Johnson was an old-timer and a regular "down East Yankee" with more original ideas than any other man I ever knew. Jake Grumbling, or "Grumps," never agreed with anybody and was even known to argue against his own convictions at times, just to be obstinate. Still, his contrary ways often brought out points that otherwise would probably have been passed over. Roy Winters, the tannery engineer, was a quiet fellow and a good listener, and last but not least, was George Myers, who always wanted to know the cost of things.

The discussion the evening I bring these characters to the reader's attention was upon coal-conveying machinery, and although none of those assembled had such apparatus installed in their plants, they all had something either for or against them and spoke their convictions accordingly, especially Mike Casey, the fireman.

As I took my seat at one side of the lodge room, Casey was giving vent to his opinion as to coal conveyors in general.

"Misther Prisident: Ther's but wan coal conveyor thot's worth a domn, and thot's the wan what's where 'tis left and in workin' order when you wants it. Wid a conveyin' systhem 'tis the divil himself what knows how long it will convey coal, ashes or nothin'. Firsht it's the domned buckets will cock up where the've no business to, and thin the firsht thing anywan knows half of the riggin' is pulled out av place and the divil's to pay. Wid the whalebarrow, when wan is done wid it, it sthays where 'tis put, and divil ther dido will it kick

up. The thing to kape a fireman contínted is to have wan good whalebarrow and a domn good mon to push it." These remarks were punctuated by the speaker with copious whiffs from a short, black clay pipe that had seen hard service.

"Mister President, it's a lucky thing that everyone don't have the same opinion as Casey about coal conveyors. If they did, there would be considerable difference in the management of some of our large power stations. I don't believe that large stations could get along without such arrangements. Just think of the amount of coal that must be handled every twenty-four hours, let alone the ashes to be taken care of. I take it that these conveyors are mighty handy in a plant. I suppose the reason Casey is down on them is because he would be obliged to oil the bearings once in a while, and that is enough to break his heart;" and Pompadour Semple shot an amused look at Casey as he sat down, to see how that worthy took it.

We all grinned at the remarks of young Semple, and then Joe Sumers got the floor.

"It all depends on the kind of a conveyor you've got to deal with," said he. "There's some kinds I wouldn't have in my plant if they were put in for nothing.

"TO KAPE A FIREMAN CONTINTED, HAVE WAN GOOD WHALEBARROW AND A GOOD MON TO PUSH IT"

I've seen 'em put in where the whole thing was only a big tub that would tip and that ran on a track. When the men wanted to get more coal, they just had to push the thing 'long like a mule 'round to the coal bin, shovel it full and push the loaded tub back in front of the boiler stoker wanting coal. Then one of the men had to climb on one of the stokers and unlatch the catch, get down again, and then with a whole lot of wasted energy tip the coal into the hopper and repeat the same operation again for the rest of the stokers.

"I've often wondered where the labor-saving came in, and I came to the conclusion a long time ago that they are not money-savers, and I don't know that I ever heard anyone claim that they were in a small plant. I knew of one conveyor that worked real prime if you just knew how to take the critter, and then there was no trouble whatever. The chief, who knew his business, had a man stand at each corner turn, and if one of the buckets kinked, the man hit it with a club. That system worked fine, and I never heard any complaints from anybody except the men who juggled the clubs."

"Mr. President," exclaimed "Dusty" Miller, "I think Joe is a little hard on conveyors in general. If there wasn't some good in 'em, it stands to reason that they wouldn't be put in. They must surely have the goods somewhere. Them push buckets are for places where the coal is unloaded through a hole in the sidewalk, the only place where it can be unloaded, and they are a whole lot better than carting it from the bin to the boiler room in a wheelbarrow. I guess conveyors save labor and space for storing coal, as the coal can be stored overhead; without the system it would have to be stored outside the boiler room. Considerable room would be taken up by the coal in front of the boiler, but with the conveyor less space between the boiler fronts could be used and the building made smaller. That would make a saving in the first cost of the building which would greatly offset the first cost of the stoker. Then again, there is the freedom from the dust and dirt that go with hand firing. Give me the stoker, although I never had one in my life;" and "Dusty" sat down with a satisfied attitude.

"'Dusty' makes connections when he gets into the question of costs," said George Myers, springing to his feet. "Costs! That is the essence of everything. Business is operated on the cost of things. If more engineers and manufacturers were to look into the cost of material and supplies, they would think twice before they got into deep water. How many of this bunch knows what it would cost to put in a coal conveyor? And if you did know, there ain't one of you who could tell how much one would save over hand-firing and Casey's way of handling the coal from the pile to the furnace and the ashes out to the ash-pile.

Nothing Saved in Building Cost

"While the saving in the cost of the building might be considerable, it wouldn't ever flood the country with dollars. The boiler room would have four walls just the same. The saving in building cost would be merely in the roof, floor and a little on the two ends of the building. It would cost nearly as much to dig a trench to put the conveyor in and braces to hold it up over the boilers as the saving in the building cost would be.

"If there was any saving in costs, it would be in the number of men employed in the boiler room, and when the first cost of the conveyor is taken into consideration, the interest on the money expended and the maintenance, it is a question whether there is any saving in the cost of operation. I am of the opinion that cost has very little to do with the matter. It is a matter of convenience."

"Convenience nothing!" growled "Grumps," springing to his feet and shaking his fist at Myers. "These powerhouse fellows would spend twice the amount they do in these labor-saving devices if they thought that they could keep a man out of work. Saving don't amount to anything with them; it's the idea of keeping a man down and out that tickles them, and the more they get us down the better they like it. It's the same with everything; there's only one way to remedy this thing and that is to have every man share alike and ——"

"Shut up!" yelled Semple from across the hall. "This is no political meeting. We are engineers and not grafters. Your governor is out of order again, and your boiler's blowing off," and with this sally, Semple relapsed into silence 'mid the pounding of the president's gavel to preserve order.

"Th' question of coal conveyors can't be put t' one side, like an old discarded horse," said "Dad" Johnson, when quiet had been obtained. "There are too many points in their favor for that. Th' first cost is controlled by th' layout of th' power plant. If th' boilers are hand-fired and th' coal can be conveniently delivered to th' boiler room in th' original shipping cars, a coal-conveyor system would be an expensive luxury. Take for a sample Joe Sumers' plant. He has a carload of coal run into th' boiler room on a standard-gage track on a trestle. The only thing to do to get that coal in front of th' boiler is to dump it on th' floor under th' trestle. As th' boilers are hand-fired, th' coal is dumped handy for th' firemen. There couldn't be a cheaper way of delivering th' coal to th' furnaces, and th' installation of a coal-conveyor system would be foolishness in his plant."

"Thim be my sentiments exactly," interrupted Casey, with nods of approval, as he stuffed the burning tobacco into the bowl of his clay pipe with his forefinger.

"That is only one case," continued Dad. "There are hundreds of small steam plants where th' coal is carted from th' railroad sidin' perhaps a mile or more and dumped on th' boiler-room floor. Most small plants are hand-fired and even though they might be equipped with mechanical stokers, a coal-conveyin' system would not be necessary or even desirable.

"Now in cases where th' boiler-room furnaces consume large quantities of coal and th' coal is delivered in large shipments, some provision has got to be had for handling th' coal quickly. It would take a bunch of wagons to keep some of th' large power plants supplied with coal, and th' labor cost would make that way of coal conveyance a mighty costly proposition."

Large Plants Must Have Conveyors

"I don't see why it should, any more than for a small plant, comparatively speaking," interrupted Roy Winters.

"Th' difference is in th' fact that a conveyor in a small plant isn't required because th' fireman does not have enough to keep him busy half th' time. If a coal-conveyor system were installed, it would not cut th' operating expense any, because th' fireman would draw th' same weekly pay, and th' cost of th' conveyor would be an addition to th' first cost of th' plant, as well as to th' cost of operation, without any feature to offset these costs."

"That's the idea," exclaimed George Myers, without recognizing the chair. "It's these useless costs that puts more small power plants in a line to be grabbed up by central stations, than anything else. They don't use common sense and figure out the cost of this and that apparatus they put in, regardless as to whether they are required or not. They do these things just because so-and-so has them in his plant, but the difference in design and in requirements are lost sight of. But go on, 'Dad,' I didn't mean to interrup' you," and Myers sat down and "Dad" went on by saying, "With th' moderate- and large-sized plants th' situation is different. Th' coal come in carloads and must be emptied with dispatch to escape demurrage charges. There must be some place to store th' coal, and so long as it must be unloaded from th' car, th' best thing is to discharge it where it will not have to be handled again. That place is naturally in a bin above th' boilers, and in order to get th' coal into that bin, th' coal conveyor is brought into use—not only because it is convenient, but because it is th' only practical way of getting th' coal from th' car to th' overhead coal bin. If th' coal conveyor were discarded, th' largest boiler plants throughout th' country would have to be remodeled in more ways than one."

"Well, what would be the result?" growled "Grumps." "Business would keep right on, wouldn't it?"

"Business would not suffer, but if hand-firing were resorted to, it would mean an increase in the boiler-room force, and even though stokers were used, it would still mean additional men over those required with overhead delivery."

"How about the cost?" asked Myers, as he threw a cigar stub into a cuspidor.

"That," replied "Dad," "is hard to state offhand, because the requirements of different installations differ and one type of conveyor is more adaptable for one plant than another type."

"Mr. President: I move we shut down and go home," motioned "Grumps." "We have spent the evening talking about coal conveyors, and there ain't one of us knows enough about 'em to start the motor what drives 'em." Whereupon the meeting was declared adjourned.

Lubrication Engineering

By John R. Battle

In the past the selection of the most economical and efficient lubricant for a definite purpose has been based upon the judgment and experience of the operating engineer or upon rough tests in which an attempt was made to secure some actual comparative results.

With the development of lubricating engineering it is now practical to define certain standard methods of conducting tests by which a comparison of the ultimate cost and economy obtained by the use of the lubricants under investigation may be definitely determined. In order to define a fair test for the comparison of lubricants, the economical merits of the lubricants under investigation must be decided purely from a technical and practical operating standpoint, and all reference to, or consideration of, the numerous claims made for lubricating oils, pertaining to the advantages of any particular crude oil, must be ignored. The relative economy of lubricants may be determined with as much exactness as is obtained in the comparison of the heating values of the various coals or the efficiency of steam boilers.

The engineer should be equipped with the proper apparatus and system for checking the deliveries of oils made to the plant under his charge. The apparatus required is inexpensive and the method of operation easy.

Checking deliveries and conducting comparative-efficiency tests of lubricating oils, as outlined in the following, may be used as a guide in formulating other tests to meet particular requirements. The apparatus required consists of a platform scale, a Baumé hydrometer (for liquids lighter than water), a thermometer, a hydrometer jar and a gravity table (see gravity-weight table). A good hydrometer may be obtained for $1.25 to $1.75, and some are equipped with thermometers, so that the two instruments may be obtained for the same outlay.

When oil is received the barrel and oil are weighed (gross weight) and the barrel is then emptied and thoroughly drained by gravity. For heavy oils at least an hour and a half should be allowed for draining and if

convenient, two hours. A sample of the oil is taken and its gravity is measured and the temperature taken.

For engine and machine oils the gravity may be taken at ordinary room temperatures. For heavy oils and cylinder oils, warm to about 100 deg. F., so as to make them more fluid, then correct the gravity reading for temperature. This is done by filling the hydrometer jar with oil and gently inserting the hydrometer so that it will not bob up and down, causing oil to adhere to the tube above the surface of the oil and thus weighing the instrument. Read the hydrometer scale by looking along the surface of the oil and allowing for any capillary attraction. Note the temperature of the oil at which the gravity is taken. An approximate temperature correction of the gravity reading may be made by deducting 1 from the gravity reading for every 10 deg. F. the temperature of the oil is above 60 deg. F. or adding 1 to the gravity reading for every 10 deg. below 60 deg. F. The temperature correction refers the gravity reading to the standard temperature of 60 deg. F.

COMPARATIVE TABLE OF WEIGHT AND GRAVITY

Liquids Lighter than Water at 60 Deg. F.

Deg. Be.	Specific Gravity	Actual Weight per Gal.	Deg. Be.	Specific Gravity	Actual Weight per Gal.	Deg. Be.	Specific Gravity	Actual Weight per Gal.
10	1.0000	8.32	22	0.9210	7.67	34	0.8536	7.11
11	0.9929	8.27	23	0.9150	7.62	35	0.8484	7.07
12	0.9859	8.21	24	0.9090	7.57	36	0.8433	7.03
13	0.9790	8.16	25	0.9032	7.53	37	0.8383	6.98
14	0.9722	8.10	26	0.8974	7.48	38	0.8333	6.94
15	0.9655	8.04	27	0.8917	7.43	39	0.8284	6.90
16	0.9589	7.99	28	0.8860	7.38	40	0.8235	6.86
17	0.9523	7.93	29	0.8805	7.34	41	0.8187	6.82
18	0.9459	7.88	30	0.8750	7.29	42	0.8139	6.78
19	0.9395	7.83	31	0.8695	7.24	43	0.8092	6.74
20	0.9333	7.78	32	0.8641	7.20	44	0.8045	6.70
21	0.9271	7.72	33	0.8588	7.15	45	0.8000	6.66

Next refer to the gravity table and select the weight per gallon corresponding to the corrected gravity. Weigh the empty barrel (net weight) and subtract the net weight from the gross weight and the result is the weight of the oil.

$$\frac{\textit{Oil weight}}{\textit{Weight per gallon}} = \textit{Number of gallons oil at 60 deg. F.}$$

The following form may be used to keep the records of delivery:

DELIVERY FORM

Brand ..... Date Delivered ..... Date Tested .....
Weight barrel and oil (gross weight) ..... Gravity @ .... F. .....
Weight barrel (net weight) ..... Corrected gravity .....
Weight oil ..... Weight per gallon .....
Weight oil ..... Gallons oil delivered
Weight per gallon ..... Gallons billed by oil company
Gallons adjustment
Checked by .....

The advantages of the weighing method over the measuring method for checking the deliveries of oil are as follows: Owing to personal error, the quantities obtained by the measuring method may vary from ½ to 4 gal. per bbl., even though great care is used in making the measurement; after a little practice it is quicker and cleaner; owing to expansion in summer and contraction in winter, the measuring method never gives accurate results, but the weighing method is equally accurate at all times; the buyer and the manufacturer are both working at the same temperature, and confusion is avoided; in the summer unscrupulous dealers take advantage of the expansion of the oil and deliver a decreased gallonage.

The method of test to compare the relative economy of cylinder oils requires a steam-engine indicator, with suitable indicator rig, cards, etc. The object of the test is to determine the relative ultimate economy of several cylinder oils. For illustration assume that it is desired to compare two cylinder oils as follows: Oil A, now in use, costs 35c. per gal., and oil B, proposed, costs 45c. per gal. Which is the more economical?

First fill the lubricator with oil A and attach the indicator and adjust the rig. Next adjust the bearing lubricators to insure good lubrication and run the engine at full speed and no load. Then take a set of three diagrams from each end of the cylinder. Next shut off the cylinder lubricator and throw on the load and run the engine with no cylinder oil for three hours; then take three indicator diagrams to obtain the friction horsepower when running dry. Fill the lubricator with oil B and run the engine for one hour with the same rate of oil feed as used with oil A, and take three sets of indicator diagrams to obtain the friction horsepower when using oil B.

As an illustration, assume a 14x28-in. plain slide-valve engine directly connected to a generator, all engine and generator bearings to be equipped with flooded lubrication; normal engine speed, 130 r.p.m.

Feed oil A at 5 drops per min., which has been found by experience to be the minimum amount that will run the engine without signs of distress from the cylinder and valves. At full speed and no load on the generator, the indicated horsepower is 23.3; when running with no oil it is 29.7. When running at full speed and lubricated with oil B, at 300 drops per hr. or 5 drops per min., the indicated horsepower is 18.7.

By reducing the feed of oil B to a minimum of 210 drops per hr., or 3.5 drops per min., it is found that the friction horsepower is not increased nor are any signs of distress produced.

When using oil A the friction horsepower is 23.3; when using oil B the friction horsepower is 18.7 and the difference in horsepower saved is 4.6. Assuming the cost per i.hp. per year to be $57, then 4.6 × 57 equals $262.20 saved in the cost of fuel and attendance. The minimum feed of oil A equals 5 drops per min., the minimum feed of oil B equals 3.5 drops per min., and the difference is 1.5 drops per min. saved. Figuring 4,500 drops per gal., which is an approximate value, $\frac{1.5 \times 60 \times 24 \times 365}{4{,}500}$ equals 175.2 gal. saved per year. Assume that this engine had been requiring 580 gal. of oil A per year, then 580 — 175.2 equals 404.8 gal. estimated with oil B. Therefore it is found that by using oil B, a saving is made. The cost of 580 gal. of oil A at 35c. equals $203 and the cost of 404.8 gal of oil B at 45c. equals $182.16, an estimated saving in oil cost of $20.84, which, added to the saving of $262.20 in the cost of fuel and attendance, makes a total saving per year of $283.04 when oil B is used.

This method of test may be adapted for shafting and other oils.

Safety the Real Reason for Boiler Laws—On a recent visit to Maryland in the interests of boiler laws, Thomas E. Durban, chairman of the administrative council of the American Uniform Boiler Law Society, ran across a striking illustration showing the necessity of legislation of this kind.

The City of Baltimore has a boiler-inspection law that does not apply outside of the city. The city inspectors condemned a boiler in a plant in Baltimore, and the man put in a new one, selling the old one as a second-hand boiler, and it was installed in a factory on the Eastern shore. About six months later the boiler blew up, killing six people outright, seriously injuring several others and causing considerable property damage. The Workmen's Compensation Bureau of the state is now working on the case.

Editorials

Two Kinds of Engineers

There are engineers who are always having trouble—always complaining. They have never had experience with anything that they would sincerely recommend. On the other hand, there are engineers who are always pleased with their equipment and speak well of it.

The following conversation, which took place in a boiler room not long ago, is typical of the first class of engineers: "How do you like your —— stoker?" "It's rotten," was the answer. "Do your —— boilers perform all right?" "They're junk. They ought to be thrown out. I much prefer the —— boiler." "Is your —— heater all right?" "No. To tell the truth this whole plant should be blown up with dynamite."

Now this man is not such a bad engineer. He knows his business and gives his employers good service—more than their money's worth. It seems that he just has an idea that it is necessary to complain about everything in order to make his friends believe that he is head and shoulders above his plant.

In the same town is another plant of about the same size, equipped with the same kind of stoker and with the same make of boilers. It is a noncondensing plant and in general is a facsimile of the one just described.

The engineer in charge of this plant made replies that were diametrically opposite to those just mentioned. He is well pleased with everything. He would occasionally remark, "They say the —— engine uses less steam than this, but we are getting along first-rate."

Things look a little better in this plant. Everything is shipshape. Railings are polished, machines are carefully wiped, the floor is scrubbed clean, and nothing is allowed to lie around in a disorderly fashion.

The other plant looks good too, but not so good as this one.

It is fair to conclude that the good-natured engineer gets just a little more power out of his coal—perhaps quite a lot. He probably keeps his boilers cleaner inside, his heater cleaner, his grease extractor cleaner, his engine better lubricated, etc. It is reasonable to assume that he takes better care of his machinery because he likes it better than the grumbling engineer likes his.

Deferred Maintenance

It is singular how harmless an objectionable policy can be made to appear by clothing it with high-flown phraseology and introducing it to society through the annual report of a board of directors. "Deferred maintenance" is one of these verbal cloaks, which covers a vast amount of plant wear and tear and lulls the stockholder and sometimes the manager into a false state of mental repose. Of course there are times when repairs must be put off, but let us not delude ourselves into thinking that as a general rule money can be deflected from the maintenance account into the dividend check without paying the ultimate penalty of increased depreciation and enlarged repair bills. If a curve could be plotted to show the rate of repair-cost increase which accompanies delay in carrying out needed work of this kind, much of the temporizing of plant owners would give way to a promptness that is best expressed by the proverbial stitch in time.

Not only is there a tendency for repair costs to mount when maintenance is delayed, but often operating expenses are increased by a failure to put faulty equipment into shape with all possible speed. Reason must govern in all things, but this does not mean taking refuge in long words as a cover for a policy that is defensible only where it can plainly be shown that the immediate losses resulting from the withdrawal of equipment or apparatus parts from service will be so great as to justify operation for a temporary period under subnormal conditions. The classification of accounts is a fine thing in its place, but it is dangerous to allow it to delay necessary expenditures.

Steam-Turbine Accidents

Much has been published in technical papers about engine accidents and breakdowns. Engineers long ago became familiar with the causes of bursting flywheels, the reason why cylinder heads were blown off, why valves became leaky and what caused governors to give trouble. In general these accidents were classified into those due to gross carelessness and neglect, those due to water in the steam or from the condenser and those due to worn parts. Operating engineers became educated in the methods of preventing these accidents, and when such occurred, the men in charge were frequently able to do much of the repair work themselves.

The first steam turbines were naturally subject to many accidents, for materials were being employed in new ways and little knowledge was available regarding their performance under such new conditions. These troubles received the closest attention from the builder in the endeavor to find the cause and to eliminate it in future designs. Repairs were always made by men from the factory, and the operating engineers were seldom given the full facts of the case.

Engineers have confidence in all the standard types of turbines now on the market, as far as operating reliability is concerned. When new machines are purchased, the choice of type is largely a matter of cost and economy guarantees, together with the personal preference of the purchaser based on friendly association with one of the builders, or former experience with a particular type. Operating engineers have now become familiar with steam turbines and have learned to let them alone when running well. The time therefore seems favorable for more open discussion of turbine accidents, together with ways and means of preventing them.

Turbine accidents and troubles are very few now compared to conditions of a few years ago. Still, certain troubles occur and would bear discussion by those that have experienced them—such, for instance, as the effects

of wet steam on low-pressure blading, the distortions of casings from sudden changes of superheat and of vacuum, blading troubles with pressure-velocity stages, failure of oil supply and difficulties with regulation. Some of these difficulties can be foreseen by those who can distinguish the symptoms, and remedies can be applied before serious conditions develop. This does not necessarily mean that the engineer should be encouraged to tinker with his turbine. But a more extended knowledge of the experiences of others should make him more capable of meeting trouble when it occurs than if he were in blissful ignorance of such a thing as a turbine accident.

Builders could profitably discuss some phases of accident prevention as applied to their machines, for the greater the working knowledge of the plant engineer the fewer will be the preventable accidents in that station.

⁂

Repair Your Repairs

It is self-evident that it is necessary to repair a pump, an engine, a boiler or anything else in time to save a shutdown or accident. If a cylinder head cracks, repair it. If a crank arm breaks, repair it. Thousands of repair-job kinks have been published covering nearly every conceivable break, and it has been proved time and again that small repairs like this save serious situations. Even as children our mothers drummed it into us that a stitch in time saves nine.

But in engineering it is a little different. Equipment should be at its best at all times—especially parts that must resist high stresses or that are vital to highest efficiency or greatest strength. Patches and broken parts should therefore be removed from a broken cylinder head as soon as possible. Parts that have been mended should be replaced by new parts. This is good logical doctrine. Patches are unsightly and are undependable as permanent fixtures.

There are exceptions to the rule, of course. One may say: "Why, I fixed up the old piston in Engine No. 3 so well that it's better now than when new; I wouldn't replace it with a new piston for anything." Maybe so. Much depends upon circumstances. Judgment always plays an important part in running a power plant. Nevertheless it is fitting to call attention to repairs that have been made in the years gone by—are they all right? Are there not some repairs that need repairing?

⁂

Preparing Alternative Designs

The engineer who is asked to submit a sketch of an improved plant or equipment layout often finds that a single design fails to meet all the requirements. Different schemes possess varying advantages. After thoroughly studying all the points, the engineer generally will conclude that a particular layout is the best under the circumstances and will go into the office prepared to advocate this scheme. It is wise, where time permits, to take other studies into the conference room; for often the discussion of a particular problem of this kind broadens at the first opportunity, and the engineer who can comment intelligently upon the merits and demerits of various plans adds to his reputation as a man of comprehensive ideas and, besides all this, helps the manager to reach a better solution of the questions at issue if alternative schemes are brought in.

Common sense must govern the presentation of optional designs, and the main thing is to have more than one solution ready. Let the engineer defend vigorously the plan he considers best, but let him appreciate the possibilities of other plans within their fields. Here the loose-leaf book comes into use very effectively. Finished drawings are seldom necessary in outlining schemes of equipment arrangement, and it is often easy to prepare pencil sketches of quite a number of layouts on loose-leaf sheets for handy use in discussions with one's superior. If a large number of these are to be prepared, the use of cardboard templates cut to scale and outlining the floor space occupied by different pieces of apparatus will save much time and trouble.

The more one studies plant layouts—and these should always interest the operating man—the more one sees that even in the design of extensions and in the rearrangement of stations in modernizing equipment, multiple solutions are necessarily considered in order to attain the best ultimate design. And it is well for the operating engineer to make a personal study of plant design, even in installations where he sees little probability of being called upon to present his ideas. The day is coming when the advice of the men who are to handle the plants after they are completed or rebuilt will be heeded and invited more than at present, and every alert and ambitious engineer should give part of his thought to this class of problems.

⁂

There is nothing singular in the fact that coal will be burned up in a down-draft furnace.

⁂

It would make many mathematical sharps step some to calculate the foot-pounds of energy required to wind an ankle watch.

⁂

Are there too many engineering societies? asks the *National Engineer*. No; not enough engineering in some of the societies.

⁂

To prevent American citizens getting "soaked," President Wilson may find it expedient to appoint a water-power commission.

⁂

In Colon, Panama Canal, where ice costs $18 a ton, an ice plant will be built and ice sold for $6 a ton. A veritable thaw in price.

⁂

The time is here when anchor ice on the intake screens makes the hydro-electric man shiver with dread and get feverish with excitement.

⁂

Change from twelve-hour to eight-hour shifts results in saving per fireman of sixty cents a day.—*Electrical World*. The engineer knows that this is possible in a reasonably large plant, but who is going to convince the manager to get him to O.K. such a proposed change?

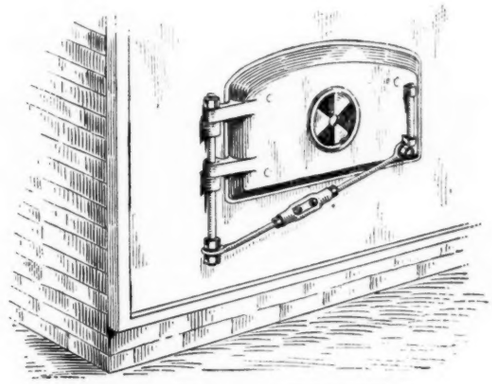
⁂

It is reported that the Federal Building, Chicago, which until two years ago received its electric service from a public-service corporation, has saved twenty-five thousand dollars by furnishing such service with its own plant. This reminds us that many readers would like to know just what it is costing the Government for light, heat and power for the Brooklyn and the New York (Eighth Avenue) post offices. Neither is served by its own plant.

Correspondence

Old Fire-Doors Made Usable

The suggestion in the issue of Dec. 28, 1915, page 906, relative to making old fire-doors usable is interesting, but the method described has the disadvantage of rapid wear at the rod connection with the angle iron, and there is also more or less heat at a location above the door and a subsequent warping of the rod and the angle iron, requiring frequent straightening. The repairman in a



DOOR SUPPORTED FROM BELOW

large industrial plant having a number of boilers to care for uses the method shown in the illustration.

The door is first blocked in position, and with a ratchet and extension drill (an ordinary drill welded to a long shank) the holes in the hinges are reamed out to about 1 in. diameter and a new hinge pin extending about 9 in. below the bottom hinge is used. A turnbuckle rod is fastened to the lower end of this pin by two nuts, as shown.

This makes a substantial arrangement, obviating wear at the rod because it forms a part of the swinging hinge pin and door; there is no warping from heat, and the turnbuckle adjustment takes care of the sag. It is also a neat-appearing job and will give perfect satisfaction if the parts are proportioned to the weight of the door.

Perth Amboy, N. J. ROBERT FULLERTON.

City Needs Boiler Regulations

The necessity for laws regulating the construction and installation of steam boilers was recently impressed on me when I came across a new boiler installed in an ice manufacturing plant. It is 72 in. by 18 ft. with a 36-in. dome. One course is 10 ft. and the other 8 ft. long, with longitudinal lap-seams double-riveted. The braces are welded iron. There are two manholes 9½x14½ in. in the front head, one above and one below the tubes. Each has cast manhole rings. The top one is directly opposite the top plate of the boiler front, which makes it almost impossible to enter the manhole.

This boiler was installed with a vertical check valve in a horizontal feed line connected to the blowoff pipe. The tube blower and steam-jet piping were connected to the steam pipe of the water column. A valve was placed in the steam line to the water column, but none in the lower pipe, which was connected to the boiler close to the bottom of the head. Then piping was run through the brickwork over the fire-door. The safety valve was set for 120 lb., giving a factor of safety of less than four.

This outfit is installed in a large city where, it is needless to say, there are no municipal or state laws regulating boilers. Why will some manufacturers still build and install a mess like this? J. T. HANOVER.

Cincinnati, Ohio.

Renewing Economizer Tubes

Responding to the call for methods of putting in and taking out economizer tubes, as made in an editorial in the Feb. 8 issue, I offer the following:

It is not possible to state any definite time for renewing an economizer tube, for there are many variables. The temperature of the flue gases, of the water entering and leaving, and whether gas is ever permitted to flow through the economizer when it is empty—all these will have a bearing upon the difficulty of starting a tube from its seat.

The age of the apparatus and the seriousness of the softening action of the hot water determine whether a tube may be pulled or relieved at both ends by chipping. The position of a tube—that is, whether or not it is under the scraper-driving mechanism—will influence the time also.

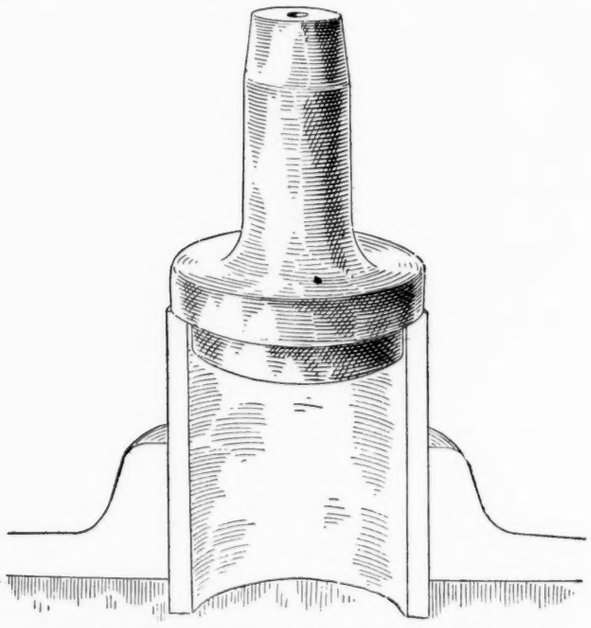
In preparing to pull a tube care to see that the tools are in proper condition often saves much time and not infrequently may prevent a broken lower header. The hook used to pull the tube should be examined and its projecting lip seen to be square with the rod and straight, so that it may take a full bearing on the bottom end of the tube. This is important, for if a tube starts hard and the bearing of the hook is poor, the end of the tube may start to crush at the point of bearing and continue to break as long as the pull lasts. Frequently, when this happens the wedging action will crack the header where the tube enters, and this entails pulling all the tubes in that section so as to put in a new bottom header, together with a possible loss of some of the other tubes. This on an economizer section twelve pipes wide becomes a considerable job.

Before the puller or drawing bar is used, attention should be given to the threaded end. The nut should be extra thick—one twice the thickness of a standard nut is good: this makes the bite on the threads less severe and is not as likely to split or strip the threads when pulled tightly. The nut should be run down on the thread beyond any point it is likely to reach in use for two reasons—to see that there are no bruises on the threads to cause it to bind, and to make sure that some previous excessive strain has not stretched the threaded part of the puller and changed the pitch of the thread from that of the nut.

Attention to these details will tend to lessen the torsion on the puller, which, if excessive, may cause the hook end to twist or slip, or even force the backing-up wedge against the side of the tube hard enough to crack it.

Care should be taken in selecting the material used for blocking up from the top of the header to the nut on the puller. The piece next the header must be stiff and rigid and yet leave room for the rod of the backing-up wedge. A piece of wrought iron 4x6 in. and 1 in. thick, with a hole in the center for the puller, does well. Round collars, with ends faced so they seat square and solidly, are satisfactory.

Sometimes when a tube is found to start very hard, a slight jarring of the blocking under the puller nut or



TOOL FOR DRIVING ECONOMIZER TUBES

of the tube itself when accessible, will serve to cause it to break away from its seat, for like all taper fits, the slightest motion imparted when under a tension will cause it to loosen.

Frequently a downward blow, using a long set, directed against the top end of the tube will cause it to start; but care must be taken or the set may not rest on the tube end, but on the header, which may easily be broken by a blow when under so heavy a stress.

The foregoing applies more particularly to tubes having the taper in one direction, as the Sturtevant, in which the joint at both ends of the tube is broken simultaneously by the action of the puller. Where the taper is in opposite directions at the two ends, as in the Green, it is of course necessary to chip out the top end before starting to pull the tube.

As there will be no metal-to-metal joint at the top end of the repair tube in this case, extreme care need not be used to prevent any injury to the surface of the joint in the top header, though a good workman would see that no unnecessary damage is done.

In thus cutting out a tube three cuts may be made equidistant from each other, down the tube to a point below the enlarged part. This is best done with a long chisel somewhat similar to a cape chisel, beveled on one side only like a wood chisel, but to an angle of about 60 deg. These cuts may be quickly made. When made, a nick is cut around the inside of the tube at a point where it is desired to break off the enlarged portion. This may be done with the same chisel if necessary, by tipping it as much as possible, but is more easily done with one bent so as to be backed up by the opposite side of the tube when in use.

When this nick has been well cut in, the top of the tube is easily broken off by driving a chisel between the tube end and the header.

Undoubtedly one of the boiler-tube cutters using a wheel acting on the inside of the tube would do this work much more quickly and effectually than nicking around with a chisel, although I have never tried it. The shaking up given the tube during this work frequently causes it to start easily from the bottom header when the puller is applied.

For making the rust joint at the top end of a Green repair tube, the "old reliable" is cast-iron borings and sal ammoniac, but a marketed cement will do or one of litharge and glycerin. Both must be allowed ample time to set properly before water and pressure are applied. With the regular rust joint I use just water enough to make the mixture work readily and calk it in thoroughly. This part of the job requires care and skill.

I have never seen a repair tube put in a Green economizer in less than three hours, but on the Sturtevant, when there was nothing in the way and with three men on the job, I have heard them call for the water to test out in an hour from the time of start, and I have had a 1,000-tube economizer on the line in less than three hours from the time it was cut out. On the other hand, I have known it to take two or three hours to coax a Sturtevant tube from its seat without damage to the headers.

In putting in the new tube it is the custom of some to wash the fits with sal ammoniac before driving, so that the surfaces may rust in, but in my opinion just as good or better results may be had by applying oil to the surfaces after cleaning them.

In driving a new tube the lower header should be supported directly beneath by a well-fixed jackscrew set up so as to furnish a solid support. This serves to prevent danger of breaking the lower header or of loosening the adjacent tubes.

For driving, a special tool is supplied. The end of the tool that rests on the tube end is made with a faced shoulder slightly smaller in outside diameter than the tube end and with a projection of ½ in. or more and ⅛ in. less in diameter than the internal diameter of the tube, so that it seats squarely and central on the tube. The shank may be 2 in. or more in diameter and long enough to be readily held while the tube is driven by moderate blows with a 10-lb. sledge. The blow struck should not be too heavy nor should the driving be continued after the tube appears tight, as it is easy to split a header. See the illustration.

Occasionally a cap may be found that cannot be made tight by cleaning and wiping with oil. If it is not too bad, a coat of white lead in oil may serve; if this fails, a narrow strip of $\frac{1}{32}$-in. sheet packing may be fitted to the opening and then the cap pulled in until it is tight. This should not be done if it can be avoided, as it is usually rather difficult to make a tight joint later, even with a new cap, without again resorting to the same means.

CHARLES L. WARE.

Maynard, Mass.

Cutting Down Cylinder Oil

Unintentionally I precipitated a discussion on cylinder-oil consumption in my former communication, published in the Nov. 30, 1915, issue, page 763. Before any more is written on the subject, let us see if there is a standard by which one can tell whether his cylinder-oil consumption is good, bad or normal. Some years ago L. Weiss investigated the subject, and his conclusions were as follows:

The cylinder-oil consumption of a compound steam engine is a function of the diameter of the high-pressure cylinder and the revolutions per minute. It is not necessary to provide any additional oil for lubricating the low-pressure cylinder. A single-cylinder engine requires the same quantity of oil as a compound engine having the high-pressure cylinder of equal diameter.

The hourly cylinder-oil consumption of a compound engine with a high-pressure cylinder 1 m. (39.37 in.) in diameter and running 100 r.p.m. is 0.455 pt., taking the specific gravity of oil as equal to 0.93. For any diameter D, in inches, and revolutions per minute N, cylinder-oil consumption in pints is equal to $0.0001155\ DN$. For triple-expansion engines the diameter used in calculating ought to be one-half the sum of the high and intermediate cylinder diameters.

The following table was worked out by Mr. Weiss:

CYLINDER-OIL CONSUMPTION IN STEAM ENGINES FOR EACH 100 R.P.M.

	Cylinder Diameter, Inches										
	10	12	14	16	18	20	22	24	30	36	42
Oil per hour, pints ...	0.116	0.139	0.162	0.185	0.208	0.231	0.254	0.277	0.347	0.416	0.485

Some more interesting data in regard to the subject were printed in *Power*, Jan. 4, 1910, contributed by J. H. Spoor, in which, as an illustrative example, he calculates by means of diagrams the 10-hr. oil consumption of a 26&42x40-in. compound engine.

Again in *Power*, Feb. 15, 1910, there appeared a table giving the cylinder-oil consumptions of 81 engines of various sizes and types, ranging from 5.94 to 0.089 pt. per million square feet lubricated, the average being 0.97 pt.

If the foregoing can be taken as a standard, it would tend to show that with ordinary intelligence on the part of the engine attendant the expression of Weiss gives an idea of the amount of oil that ought to suffice and that under exceptional conditions and with close attention the oil consumption can be measurably reduced.

Mr. Hawkins, in *Power*, Jan. 4, 1916, pp. 23-24, writes that he is using 5 pt. for a 12-hr. run. Using Weiss's table, one sees that with a cylinder diameter of 19 in. the oil per hour in pints is 0.2195. As the engine in question is making 200 r.p.m., the consumption would be $0.2195 \times 2 = 0.439$ pt. per hr., and as the engine is running 12 hr., the total consumption would be 5.268 pt. for 12-hr. run. The foregoing shows that he is doing better. In fact, owing to the low price that he is paying, he need not be ashamed of his oil consumption.

Taking Mr. Baudino's oil consumption as printed in *Power*, Feb. 8, 1916, p. 192, and comparing with Weiss's table: For a cylinder diameter of 22 in. the oil per hour in pints is 0.254, and for an engine making 200 r.p.m. and running 11 hr. per day the total consumption is $0.254 \times 2 \times 11 = 5.588$ pt., whereas he is using 1½ qt. For a cylinder diameter of 19 in. the oil per hour in pints is 0.2195, and for an engine making 225 r.p.m. and running 8 hr. the total consumption is $0.2195 \times 2\frac{1}{4} \times 8 = 3.95$ pt., whereas he is using a quart.

By working out further the results as printed in *Power*, providing Weiss's table can be accepted as a standard, one sees very clearly whether he is doing well, better, or indifferently.

Scientific lubrication is all right provided it is not carried too far. It is better to be on the safe side and use a little more oil and spare the cylinder than to try to run the engine on the least oil consumption and at the end of a year find that one has saved a barrel of cylinder oil but has had to rebore the cylinder.

New York City. G. T. MICHAEL.

The flywheel test is the best one I know of for determining the proper quantity of oil to use in a steam engine. The test is very simple. Just pull out your watch and take the time required for the engine to come to a stop after shutting off the steam. The longer the stopping time the better.

It is plain that if a flywheel weighs, say, 2,000 lb. it has a definite amount of energy stored in it when running at normal speed. Therefore, when steam is suddenly shut off, an equal amount of energy is dissipated every time the engine stops. With all conditions the same, then, an exactly identical length of time will be consumed in stopping every time the throttle is closed. By noting the stopping time every night and by altering the quantity of lubricant fed to the engine every day, the proper amount is in time determined.

The important thing is that external conditions must be the same every time the stop test is made. If the engine drives a belted machine, it is therefore best to throw off the belt and take the stopping time with the engine running unloaded. Under that condition longer time is consumed in coming to a stop and comparison of stopping times is made easier. In other words, the test is more delicate. S. F. WILSON.

New York City.

The Hall of Records Test

Your editorial in the Mar. 7 issue, concerning the Hall of Records test, contains an error of statement in reference to the proposal of this company, which we feel you will be glad to correct at an early opportunity. We refer to that part of the editorial in which you say that the offer of this company is based upon a special, or discriminatory, rate. No such offer could be made under the rules of the Public Service Commission, nor do we believe that the authorities themselves would be willing to accept a discriminatory rate.

The simple operating costs for the light, heat and power service found as a result of the test—with no allowance for "overhead"—were $39,311.51. At the rates for which the city now purchases current for the City Hall group, the cost of Edison service is estimated at $11,924.78. At the rates at which steam is now being supplied to other buildings, the estimated annual cost for this portion of the service, under the estimate of the representative of the city on the Board of Engineers, would be $24,000; under the estimate of the members of the board representing the Bureau of Municipal Research, $21,000; and under the estimate of the engineers representing this company, $18,400. The aggregate

under these three estimates, again referring to the established rates for each class of service, becomes $35,924, $32,924 and $30,324. The highest estimate includes obvious errors, the elimination of which would reduce the cost much below $35,000 annually.

It is unnecessary to point out that the "operating costs" do not represent the entire cost to the city for the operation of this plant. The agreement under which the test was conducted provided that in the final statement of cost the "overhead" should be added, including interest, depreciation, supervision, water, rent and loss of taxes. The aggregate of all, depending upon the individual points of view of the members of the board, is somewhere between $50,000 and $57,000 annually.

Trusting that you will kindly correct the statement that this company has made, or contemplates making, any discriminatory rates.

ARTHUR WILLIAMS,
General Commercial Manager.
New York. The New York Edison Co.

Cooling-Water Circulation

We are operating three motor-driven centrifugal pumps two miles from the power house, and no attendant is stationed at the pumphouse. The pumps take water from a shallow well and discharge into the city mains. One of them is for fire service only and except for a weekly test is very seldom used. The others are not in service all of the time.

The main bearings on the pumps are water jacketed and when in operation require the ½-in. regulating valve to be open about one turn. When originally installed the water for this purpose was taken from the discharge of each pump and after passing through the bearing went into a common waste pipe leading to the well. With this arrangement there was an unnecessary loss when the pumps were not running, but an attempt to save water resulted in trouble. To remedy this the common waste pipe was taken out and the water upon leaving each bearing was piped directly into the suction pipe of the pump. When the pump is not running no water flows, but when the pump is running the difference in pressure on the discharge and the suction pipes causes a circulation through the jacket. PHILIP R. DUNTON.

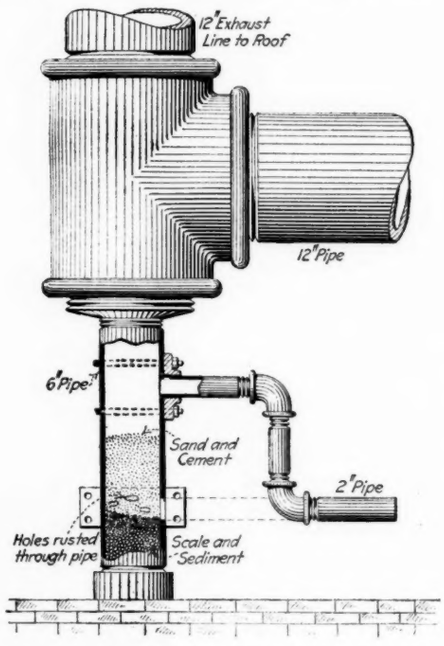
Ponca City, Okla.

Extending Life of Water-Leg

Our office-building power plant consists of four gas engines totaling 600 hp. The exhaust pipes all run into one 12-in. header, and that in turn runs to the top of the adjoining building 22 stories high. The support, which also acts as a water-leg, is a piece of 6-in. pipe 6 ft. long screwed in the bottom of the 12-in. tee, the cap at the bottom resting on a brick foundation. To take away the condensation a 2-in. hole was cut in the side of the water-leg, the saddle put on and a drain run from it. The plant has been in operation 14 yr.

Recently it was noticed that there was a leak at the saddle, and upon making an examination it was discovered that there were several oblong holes in the pipe on the line of the saddle. Upon removal of the saddle it was discovered that the water-leg had become filled with pipe scale and sediment up to the 2-in. opening and the strong acid water had corroded holes through the pipe at that point. As the pipe is located inside the wall built around the smoke-stack of the heating boilers and the back wall of the boilers is close to the stack wall, in order to have replaced the pipe in the water-leg with a new piece it would have been necessary to cut a hole in the stack wall and tear down part of the boiler wall.

Instead, I cut a new hole in the water-leg 18 in. above the old one, put the saddle on that and then had a heavy iron clamp 5 in. wide put around the pipe over the old



PARTIAL SECTION, SHOWING REPAIR

drain hole and the rusted holes, with a rubber gasket all the way around. Then I filled the pipe with concrete (2 parts sand, 1 cement) up to within 6 in. of the new hole, and after it was set, the drain was coupled up to the new position of the saddle. The pipe has not leaked since, and the cement strengthens that part of the pipe made weak by the holes. L. M. JOHNSON.

Emsworth, Penn.

Burning Barley Coal

I read with interest the letter in *Power* of Feb. 15, by C. B. Hudson, on the subject of burning very fine anthracite, and I wish to state that we are successfully burning barley or No. 3 buckwheat of 11,000 B.t.u. per lb. and containing 25 per cent. ash. We have a boiler plant of ten 320-hp. water-tube boilers, with double fireboxes 5½ x10 ft., making a total of 110 sq.ft. of grate surface per boiler.

When we began to burn barley coal, we experienced considerable trouble from clinkers. The boilers are hand-fired, using forced draft supplied by an engine-driven fan, and are equipped with a dumping grate having about 14 per cent. air space. We use from ¾ to 1½ in. air pressure under the grates and as near atmospheric pressure over them as possible.

I have found by experience that clinker formation is due more to improper handling of the fires than to the coal itself. In cleaning the fires, at first we left nothing on the grates but clean fire, and when the draft was put on, the air could be seen coming through in a few places

only, making several big red spots; and if the fire was let burn in that condition there would be as many clinkers as there were spots.

Now when we clean, we leave a mixture of fire and ashes about 2 to 3 in. thick on the grates and sprinkle the fire with a light charge of coal. The fire will burn much quicker and is not so likely to form a clinker as if only fire had been left on the grate. In case red spots should form during the firing of the boiler, a ¾-in. T-iron is used to remove the fire from the spot and increase the draft slightly.

We run our boilers from 150 to 200 per cent. rating, as indicated by a steam-flow meter on each boiler.

Pottsville, Penn. A. A. NORRMAN.

Rewinding a Small Motor

Some types of small single-phase motors have a winding similar to that shown in Fig. 1. The heavy lines indicate the main winding, while the light lines indicate the auxiliary, or starting, winding. This winding is in circuit only during starting and is cut out by the centrifugal switch as soon as the motor reaches normal speed. Both windings are made up in skeins of the required number of turns, and their circumference, which is determined by the manufacturer, is just sufficient to fill the correct number of slots. As shown in the figure, this winding consists of six large skeins for the main winding and six smaller ones for the auxiliary, or starting, winding.

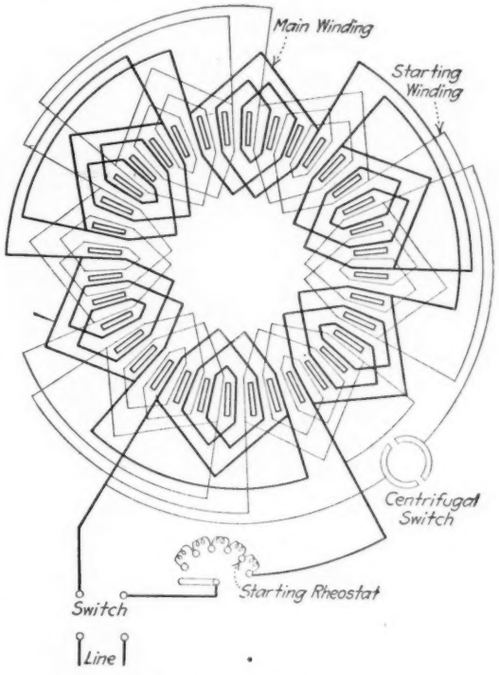


FIG. 1. ORIGINAL MOTOR WINDING

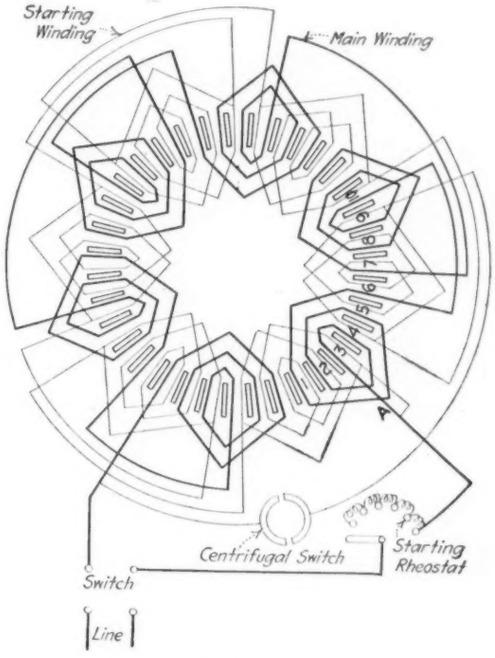


FIG. 2. ARRANGEMENT AFTER REWINDING

Some time ago a motor of this type operating a blower burned out. As no other motor was available and the burned one could not be spared long enough to return it to the manufacturer, it was decided to attempt rewinding at the plant. The wire in the auxiliary winding being of comparatively small cross-section, no great difficulty was experienced in removing it from the slots intact, so that its circumference was easily determined. The main winding was of larger wire and, owing to the baking it had received, was harder to remove, so that it had to be cut up considerably to facilitate removal. To determine the circumference of the skein by winding an experimental one would have involved a considerable loss of time and probably wire, so the following method was resorted to:

The size of wire and number of turns per slot being known, a reel of suitable wire was obtained, and starting at *A*, Fig. 2, slots 3 and 4 were filled with the correct number of turns, then slots 2 and 5, then 1 and 6. From slot 6 the wire was carried over to slots 10 and 9, the winding being reversed every alternate group of slots or poles. The auxiliary skeins were then made up and inserted as shown.

It will be seen that electrically the main windings in Figs. 1 and 2 are identical. There may have been some difference in the total length of wire between the two styles of windings, but this is not apparent in the operation of the motor, which has been running several months. As a manufacturing proposition this method of winding would not be very economical, as once the size of the skein is determined it requires much less time to insert them than the method described. However, in this particular instance the motor would have been out of service for several weeks had it been returned to the manufacturer.

Cleveland, Ohio. P. JUSTUS.

Displacement of Ammonia Compressors

Reading Peter Neff's article in the Jan. 18 issue of *Power*, one gathers the impression that clearance does not affect compressor efficiency, efficiency here referring to horsepower per ton of refrigeration. I am unable to agree with Mr. Neff on this point.

In my opinion the clearance does affect the efficiency. To illustrate: Take a double-acting compressor 21x48 in., corresponding nominally to a 250-ton unit. Assume that the clearance volume is 1 per cent. of the piston displace-

ment, or swept volume of the cylinder. The swept volume is 16,625.28 cu.in., and the clearance volume, if equal to 1 per cent. of this, will be approximately 166.25 cu.in. This volume of gas, when expanded from 185 lb. condenser pressure to 15.67 lb. suction pressure, will increase in volume approximately 6.66 times, or to about 1,100 cu.in.

This means that for every stroke of the compressor 1,100 cu.in. must be compressed from 15.67 lb. to 185 lb. I am using these pressures because they are those on which compressor ratings are based. Assuming that the compressor is run at 60 r.p.m. ($2 \times 60 \times 60 \times 24 \times 1{,}100) \div 1{,}728 = 110{,}000$ cu.ft. must be compressed to the condenser pressure and reëxpanded per 24 hr.

A ton of refrigeration requires the handling of 27.7 lb. of ammonia per hour at 15.67 lb. suction pressure and 185 lb. condenser pressure. The volume of 1 lb. of gas at 15.67 lb. suction pressure is 9.028 cu.ft. The volume to be handled per 24 hr. at this pressure to produce a ton of refrigeration will be $24 \times 27.7 \times 9.028 = 6{,}000$ cu.ft., approximately. The horsepower per ton for a 250-ton machine will be about 1.2. In other words, to compress 6,000 cu.ft. of gas at the given pressures will require $1.2 \times 24 = 28.8$ hp.-hr. To compress 110,000 cu.ft. will require $(1.2 \times 24 \times 110{,}000) \div 6{,}000 = 528$ hp.-hr.

I am aware that the energy consumed in compressing the gas is supposed to be given out again during reëxpansion and that consequently there is no energy loss. I do not believe that this supposition is correct. In an ammonia compressor, as in any other mechanical device, there is some loss in transmission from the source of power to the point where the work is done. The mechanical efficiency of an ammonia compressor of the dimensions given would possibly be about 90 per cent. In other words, 10 per cent. is lost in transmission. During reëxpansion, when the compressed gas is giving up the energy originally imparted to it, the same effect takes place; so that for every 100 hp. input we get only $90 \times 0.90 = 81$ hp. back, or a loss of 19 per cent.

The total power consumption required to compress the gas in the clearance to condenser pressure per 24 hr. for a compressor of the dimensions given is 528 hp.-hr.; 19 per cent. of this is 100.32 hp.-hr. The volume of gas in the compressor cylinder at the end of the suction stroke is equal to the piston displacement plus the clearance volume, which will be $16{,}625.28 + 166.25 = 16{,}791.53$ cu.in. Of this, 1,100 cu.in. is reëxpanded gas from the clearance space, leaving a net volume of $16{,}791.53 - 1{,}100 = 15{,}691.53$ cu.in. of new gas in the cylinder per stroke. The total volume handled per 24 hr. will be $(2 \times 60 \times 60 \times 24 \times 15{,}691.53) \div 1{,}728 = 1{,}569{,}153$ cu.ft. The power consumption will be $(28.8 \times 1{,}569{,}153) \div 6{,}000 = 7{,}531.934$ hp.-hr. The loss from 1 per cent. clearance will be $100.32 \div 7{,}531.934 \times 100 = 1.33$ per cent. of the total input. With steam consumption of 20 lb. per hp.-hr. at a cost of 20c. per 1,000 lb. and assuming a run of 250 days per year, the loss will amount to $(100.32 \times 20 \times 0.20 \times 250) \div 1{,}000 = \$100.32$.

Mr. Neff's contention that the gas in the clearance volume acts as a covering film, preventing an intimate contact of the incoming suction gas with the hot cylinder, seems far-fetched. The moment the suction valve opens, there commences a violent agitation of the gas in the cylinder, which mixes with the inrushing suction gas.

Chicago, Ill. THOMAS G. THURSTON.

Groaning in Steam Pump

In the issue of Feb. 1, page 162, Mr. Blondet asks for suggestions in regard to groaning in a steam pump. I had a similar experience with a pump overhauled in a railroad shop. When first started up it commenced groaning, and no amount of oil would stop it, so we turned our attention to investigating the cause.

I examined the steam cylinders and found no evidence of cutting, but on examining the water cylinders I found that the packing rings had been cut so long that they fitted too tightly in the cylinders and caused a drag and groan; so I cut ¼ in. off for clearance, and the groaning ceased. WILLIS W. NELSON.

Spokane, Wash.

I once had a duplex boiler-feed pump that groaned so badly that we could hardly stay in the building, and pumping oil into it did not have any effect. We faced up the metal valves, rebored the water cylinder and faced the steam valves without curing the groan. As a last resort we took out the metal valves and put in hard-rubber valves and have had no more trouble. The pump now runs as smoothly as any I have ever seen, without a groan. J. C. BOUDEN.

Wichita, Kan.

Galvanized Pipe for Ammonia

Pipe galvanized on the outside only is being used in ammonia refrigeration plants, especially for liquid lines, liquid headers and branch connections to expansion coils. Galvanized pipe has advantages where it is alternately dry and wet, as it is rustproof. It is of no advantage for expansion coils that are always frosted, as these will not rust anyway; for water headers and outside pipes of double-pipe condensers it is good.

I had been under the impression, and have always been told that the pipe must not be galvanized on the inside. Consulting engineers, in specifying galvanized pipe for ammonia work, state that it must be galvanized on the outside only. The reason given is that ammonia will destroy the galvanizing and that the ammonia will deteriorate.

While discussing this with one of the men one day, he informed me that at one time he had had occasion to overhaul a condenser that had been in service six years and was built of pipe galvanized inside and outside, and that it was in as good condition as the day it was put in.

He was surprised at the condition of the pipe and inquired of the master mechanic if he did not have trouble with the ammonia deteriorating. The latter stated that it did not do so. Later he had discussed the matter with one of the ammonia men, and he also claimed that ammonia had no effect on the galvanizing, as he had once built a condenser of pipe galvanized inside and outside and was positive that there was no effect on either the galvanizing or the ammonia.

I have noticed that where we find ammonia leaks in galvanized pipe lines, the galvanizing has come off in a dust form where the ammonia has come in contact with it. I should like to see a discussion of this subject in *Power* by those who have had experience with galvanized pipe in ammonia systems. THOMAS G. THURSTON.

Chicago, Ill.

Inquiries of General Interest

Covering Discharge Line From Ammonia Compressor—Does it make any difference in the economy of operation of a refrigeration plant whether the discharge line from the compressor to the condenser is covered with a nonconducting material? W. C.

The temperature of the air surrounding the discharge line is lower than that of the gas discharged from the compressor, and it is better to leave the line uncovered.

Stop-Cocks for Boiler Pressure Gages—What advantage is there in using single stop-cocks in place of valves for the steam-gage connections of boilers R. C. H.

The connection of a steam gage should be so arranged that the gage cannot be shut off from the boiler except by a cock placed near the gage, showing at a glance whether the cock is opened or closed. To fill this requirement the cock should be provided with a tee or lever handle arranged to be parallel to the pipe in which it is located when the cock is open.

Loss of Heat From Moisture in Coal—What loss of heat is sustained by 10 per cent. moisture in coal containing 13,500 B.t.u. per pound of the dry fuel? E. R. G.

Assuming that the fuel when fired is at a temperature of 60 deg. F., evaporating each pound of water contained in the fuel at the pressure of the furnace gases, or approximately atmospheric pressure, would require 212 — 60 = 152 B.t.u. and for its evaporation into steam at that pressure would require about 970.4 B.t.u. Assuming the temperature of the furnace gases to be 450 deg. F., the steam generated would be superheated through 450 — 212 = 238 deg. F., and as the specific heat of superheated steam is about 0.48, to superheat each pound of the steam thus formed would require 238 × 0.48 = 114.24 B.t.u., and the moisture contained in one pound of the fuel would require 10 per cent. of (152 + 970.4 + 114.24), or 123.64 B.t.u. per pound of the fuel, which would reduce the 123.6 B.t.u. per pound of the fuel. As each pound of the wet fuel contains 90 per cent. of 13,500 or 12,150 B.t.u., the moisture present in the fuel would reduce its heating value $\frac{123.66}{12,150}$ or about 1 per cent.

Feed-Water Temperature at Expense of Back Pressure—Our engine usually has a light load, and the feed water is heated to 165 deg. F. in an open exhaust-steam feed-water heater, although with full load the temperature is 210 deg. F. When the engine is carrying a light load, would it pay to increase the back pressure of the exhaust to obtain the higher feed-water temperature? G. R.

It would not pay, as less heat would be added to the feed water than required for generation of the additional steam needed by the engine for overcoming the increase of back pressure.

Value of Exhaust Steam for Heating—What proportion of the heat of steam supplied to a noncondensing engine remains in the exhaust available for steam heating? R. D. K.

Under average conditions the steam discharged as exhaust from the engine can be made to accomplish about 90 per cent. as much heating as when in the form of live steam discharged direct from the boiler. But from the waste incurred by drips and leakage of back-pressure relief valves, the heat that can be realized in average plants where exhaust is used for heating is probably not more than 80 per cent. of that contained in the steam supplied to the engine.

Actual Power Developed by Boiler-Feed Pump—If an engine in developing 500 i.hp. uses 17 lb. of steam per hour per indicated horsepower and is supplied by a boiler operated at a pressure of 160 lb. per sq.in., what is the actual power developed by the boiler-feed pump? F. L.

The weight of water pumped per minute would be (500 × 17) ÷ 60 = 141.66 lb. Allowing a loss of 5 lb. pressure for lift of the water to the boilers and friction of piping, elbows and valves, the total head against which the pump works would be 165 lb. per sq.in., which would be equal to a lift of 165 × 2.3094 = 381.05 ft., and the actual power developed would be (141.66 × 381.05) ÷ 33,000 = 1.63 hp.

Water-Hammer in Boilers—Under what conditions can water-hammer occur in a boiler? W. H. W.

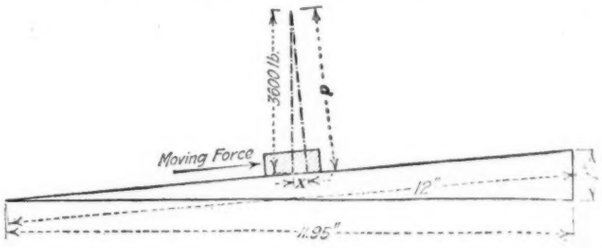
Water-hammer can occur from the projection of large or small masses of water through a space where the pressure ahead of the water is suddenly overcome by energy behind the water. As in a boiler part of the space is occupied by steam and part by water, the conditions favorable to water-hammer exist when there is a sudden release of steam, as by lifting of the safety valve combined with rapid disengagement of steam below the surface of the water, causing the water to be lifted and projected at high velocity through the steam space against the upper part of the shell. Water-hammer may occur also from condensation of steam formed in sections of the boiler that are connected by contracted passages with other sections containing water of lower temperature than that of the steam thus generated.

Power Required To Draw Weight Up an Incline—If an incline rises 1 in. per ft., what power will be required to slide a weight of 3,600 lb. up the incline at the rate of 55 ft. per min. if the coefficient of friction between the weight and the incline is 23 per cent.? M. S. M.

For moving the body up the incline without friction, the force required parallel to the plane is to the weight as the rise of the incline is to its length. Calling x the required force, then as in the figure,

$$x : 3,600 :: 1 : 12, \text{ or } x = \frac{3,600}{12} = 300 \text{ lb.}$$

The pressure perpendicular to the incline is to the weight as the horizontal length of the incline is to the length of the



POWER REQUIRED TO DRAW WEIGHT UP AN INCLINE

incline. For an incline 12 in. long with a rise of 1 in., the horizontal length of the incline would be $\sqrt{(12)^2 - (1)^2} = 11.958$ in. Calling p the pressure perpendicular to the incline, then

$$p : 3,600 :: 11.958 : 12, \text{ or } p = 3,587.4 \text{ lb.,}$$

and with a coefficient of friction of 0.23, the force required to be exerted parallel to the incline for overcoming friction would be 3,587.4 × 0.23 = 825.1 lb. and the total force required parallel to the incline would be 300 + 825.1 = 1,125.1 lb. Hence to draw the weight up the incline at the rate of 55 ft. per min. would require (1,125.1 × 55) ÷ 33,000 = 1.87 hp.

Removing Oil From Boiler—How should caustic soda or soda ash be used for boiling off a 6x18-ft. horizontal return-tubular boiler that has become fouled with oil? S. L.

After blowing off the boiler, spread 25 to 50 lb. of pulverized soda ash in the boiler and fill it nearly full of clean water, using the softest water procurable for the purpose. With the safety valve raised and manhole plate removed, hold the water at boiling temperature with a steady low fire for 12 to 15 hr. With the fire drawn the boiler then should be drained and thoroughly washed. Using about one-half the quantity of soda ash previously employed, the operation of boiling should be repeated for about 5 hr. to observe from the appearance of the water surface at the manhole opening whether the oil has been thoroughly removed. If no further emulsification appears after charging only about 25 lb. of soda ash, the water can be drawn down to normal water level and the use of the boiler can be continued with the same water. If, however, the oil does not appear to be thoroughly removed, the boiling off with the full quantity of soda, washing and test boiling should be repeated until all traces of oil have been removed.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Hydro-Electric Development Here and in South America*

By Maurice Deutsch

SYNOPSIS—A review of some of the more important water-power developments in this country and South America with special reference to Niagara Falls. Also current practice as regards types of water wheels, voltages, etc.

Without the introduction of cheap sources of power many of the great industries of this country would have been stifled in their infancy. There is no country in the world that is as rich as the United States in natural resources, and the harnessing of its water powers and the development of cheaper power will give a still greater impetus to the economic development of processes heretofore considered unprofitable.

No more marvelous development of an industrial center has ever been dreamt of than that which has occurred at Niagara Falls during the past 23 years and brought about fundamentally by the utilization of only a small part of its potential water powers for the generation of electric current. Its population has been multiplied over four times (10,000 in 1892, 42,000 in 1915); and its assessed valuation has increased from $8,000,000 in 1892, when the City of Niagara Falls was formed, to over $37,000,000 in 1914, almost in direct ratio to the increase in population. The estimated investment in power development and manufacturing establishments at Niagara Falls is now over $75,000,000, and the total value of the manufactures made there annually amounts to over $40,000,000.

At present the total hydro-electric development at Niagara Falls is only 455,000 hp. by five power companies. The average flow of the Niagara River is estimated as 222,400 cu.ft. per sec., or about 25,000,000 tons per hr. There is a fluctuation in the flow caused by the direction of the wind, ice conditions and periodic variations in run-off, so that from measurements taken during the past 55 years, the flow has varied from about 158,500 cu.ft. per sec. to over 314,000 cu.ft. Considering the total fall in the river from half a mile above the falls to the pool below as being 216 ft., there is theoretically available a total of 5,700,000 hp. Assuming a turbine efficiency of 87 per cent. (This has recently been carried to about 93 per cent.) and a generator efficiency of 92 per cent., the average available power would be about 4,500,000 hp. This may be reduced by reason of friction losses, etc., to a net 4,300,000 hp.

POWER COMPANIES AT NIAGARA FALLS

	Installed Capacity Hp.
On the American side:	
Hydraulic Power Co. of Niagara Falls	144,000
Niagara Falls Power Co.	118,300
On the Canadian Side:	
Ontario Power Co. of Niagara Falls, Ontario	120,000
Canadian Niagara Power Co.	62,500
Electrical Development Co. of Ontario, Ltd.	52,000
International Railway Co.	3,000
Total	499,800

Owing to the limitations set by the Burton Law in 1906, a diversion of only 15,600 cu.ft. per sec. was permitted from the American side of the Niagara River, only 8,600 cu.ft. per sec. by any one company, and only 160,000 hp. could be imported from Canada. Subsequently, in 1910, by the terms of a treaty between Canada and the United States, this restriction was changed to a daily diversion at the rate of 20,000 cu.ft. on the American side and 36,000 cu.ft. on the Canadian side. Although the Burton Law expired in 1911, the War Department has exercised jurisdiction and control over the amount of diversion permitted. At no time have the full treaty limitations been allowed on the American side, although some of the companies are equipped to furnish the amount of power allowed by the treaty. The Niagara Falls Power Co. was the first to develop the water power on a large scale, and in order to avoid commercial features below the falls, the power houses were located over a mile above the falls on the American side. As a result a head of only 140 ft. became available. The turbines are set in a wheelpit 180 ft. deep cut out of the solid rock. At the top of these pits are the power houses containing the generators. The water from the turbines drops to the bottom of the wheelpit, from whence it is discharged through a tunnel about 200 ft. below the surface to the level of the river in the gorge below the falls.

The Hydraulic Power Co. is allowed a diversion of only 6,500 cu.ft. per sec. Its power house is situated below the falls, where it has been possible to obtain an available head of 216 ft. The water is led by way of a canal through the city from a point about a mile above the American Falls to a point less than one-half a mile below, from where it is discharged in steel penstocks from the top of the gorge to the thirteen turbine units below, each of 10,000-hp. capacity. In order to improve the appearance of this installation, this company spent over $100,000 in constructing an immense stone wall to cover these large penstocks.

While 60 per cent. of the total watershed feeding the Niagara River is on American soil, less than 5 per cent. of the total discharge passes over the American Falls. Sooner or later some means will have to be adopted to correct this flow of the river.

The height of the American Falls is 167 ft. above the level of the river below. The width at the Welland River is 6,200 ft.; at the head of the rapids just above Goat Island it is 4,100 ft., and the depth of the water nearly all the way across is less than 3 ft., except at the Canadian shore, where it is 9 to 10 ft.

The Canadian branch of the Niagara River is 3,200 ft. wide at the head of the rapids, from where it descends to the crest of the Horseshoe Falls, where it is 1,100 ft. wide. The height of these falls is 158 ft. at the Goat Island side and 165 ft. at the apex. It is worthy of note that the river bed is below the level of Lake Ontario throughout the height of the gorge, even at the foot of the falls, except in the whirlpool rapids. From measurements taken during the past 55 years it has been estimated that the Horseshoe Falls are receding at the rate of 5 ft. a year, while the American Falls have receded only one-twentieth as much. It is by a study of this recession and other geological phenomena at these falls that geologists have estimated their age to be from 32,000 to 39,000 years.

SOME SOUTH AMERICAN WATERFALLS

Three of the most interesting waterfalls in the world are to be found in South America—the Iguazu, Nacunday and La Guayra. The Iguazu is probably the most important, its height and the volume of water being greater than our own Niagara Falls. It enters the upper Parana River about 1,500 mi. from the Atlantic Coast, at the junction of Argentine, Brazil and Paraguay, and lies in the midst of a primeval forest. It is estimated that about 28,000,000 cu.ft. per min. bursts through a series of thickly wooded islands and makes a clear leap at this point of 210 ft. into the gorge below.

About 200 ft. above the entrance of the Iguazu, on the Parana River, is the Falls of La Guayra, 310 ft. high, with an estimated flow of over 13,000,000 cu.ft. per min. The physical conditions around this falls makes it in every way a natural water power requiring only the installation of power houses and penstocks. Although the journey from the Atlantic Coast to this falls takes about twelve days, the straight-line distance, to the Atlantic Coast markets is not more than 400 mi. This entire country is wealthy in timber and other natural resources, waiting only the assistance of capital for its exploitation.

OTHER NOTABLE HYDRO-ELECTRICAL DEVELOPMENTS

Some of the most notable hydro-electric developments in the United States during the past few years are the following:

The Auglaize and Maumee River power developments, which will ultimately generate 37,500 to 40,000 hp. from four plants at an effective head of about 26 ft., will distribute power within a radius of 60 to 75 mi., to cities in the vicinity of Fort Wayne, Ind., and Toledo, Ohio.

The most remarkable development in recent years is that of the Big Creek, a tributary of the San Joaquin River on one of the most inaccessible sites in the Sierra National Forest Reserve, 250 mi. northeast of Los Angeles, Calif., and at an elevation of 7,000 ft. above sea level. The snow water from mountains 10,000 ft. high is stored and fed to two power plants, each utilizing in turn heads of nearly 2,000 ft. in horizontal distances of 2 mi. to the first station and 4 mi. to the

*From an address before the recent Pan-American Scientific Congress.

second. Power is transmitted 241 mi. to Los Angeles at 150,000 volts, for industrial, lighting and street-railway uses. The present plant has a capacity of about 80,000 hp., but it is ultimately to be developed for 400,000 hp.

A low-head single-runner hydro-electric development has recently been completed at Coons Rapids on the Mississippi River, 13 mi. above Minneapolis. This will ultimately provide about 3,200 hp. from an average head of about 17½ ft.

The Coosa River project is the first of a number of hydro-electric developments by the Alabama Power Co. in central Alabama, about 40 mi. from Birmingham. The maximum distance of transmission is 150 mi. This company is largely financed by English capitalists. The present power house will provide for the installation of six 12,500-hp. units operating under a 68-ft. head and at a voltage of 110,000. The ultimate capacity will be 400,000 hp.

Another interesting station just completed is that of the Horseshoe Falls on the Bow River, 50 mi. west of Calgary and ¾ mi. from the main line of the Canadian Pacific R.R. Above this site the river has a drainage area of about 2,000 sq.mi. By the use of two 12-ft. and two 9-ft. penstocks operating under a head of 70 ft., 19,500 hp. is being generated for distribution 8 mi. to the Exshaw Cement plant at 12,000 volts and at 55,000 volts 50 mi. to Calgary.

FEATURES OF SALMON RIVER DEVELOPMENT

The most notable features of the Salmon River Power development are the regulation of a water column 9,625 ft. long and the installation of four needle valves 8 ft. in diameter. To absorb the energy of the water in this long pipe, a differential surge tank 205 ft. high had to be installed. Bypasses provided at the turbines avoid putting the entire burden of regulation on the tanks. This station develops 30,000 hp. under a head of 245 ft. The Salmon River flows from the foothills of the Adirondack Mountains and has a fall of 650 ft. in the 17 mi. between Stillwater, N. Y., and Lake Ontario, and 400 ft. in a distance of less than 8 mi. Next to Niagara Falls the Salmon River is the best source of power in the State of New York. At the Salmon Falls, which are almost as beautiful as the Niagara Falls, the drop is 100 ft.

The Salmon River line is to be tied in with the Niagara Falls plant of the Ontario Power Co., acting in general as a source of energy, but occasionally as a synchronous condenser plant. During hours of low load it will be shut down, but at peak loads its main function is developed. Owing to insufficient storage facilities, it becomes necessary (as has been done in several instances in Europe, in one case pumping water over 1,500 feet up on a hillside) to pump back into a reservoir during low flow in the Salmon River, to be used at times of peak loads later in the day, thus enabling the plant to handle loads nearly twice that otherwise possible.

The highest-head hydro-electric plant east of the Mississippi River is that of the Georgia Railway Co. at Tallulah Falls, situated on the eastern slope of the Blue Ridge Mountains in Georgia. Energy is transmitted a maximum distance of 210 mi. to Lindale, Atlanta and the vicinity. It was put in operation in September, 1913, with a present capacity of 67,000 hp. under a 580-ft. head; the ultimate capacity will be 84,000 hp.

One of the most notable of recent power developments is that on the Ocoee River at Parksville, Tenn. The first plant, built in 1912, develops 27,000 hp. from a head of 110 ft. Development No. 2 utilizes a head of 272 ft. for an ultimate installation of 30,000 hp. The maximum flow of 1,200 cu.ft. per sec. is carried in a flume along the mountain side for 4½ mi. to the penstock intake. In order to take care of the surplus discharge when part or all of the load on the station is suddenly thrown off the turbines, a spillway is provided near the lower end of the flume and about 300 ft. above the penstock intake. In view of the insufficiency of the available length of crest to discharge the 1,200 cu.ft. per sec., eight automatic siphon spillway units were installed within the concrete of the spillway dam. Although this is the first design of such a siphon in this country, it has proved highly efficient.

In power output, and especially in physical magnitude, by far the largest hydro-electric power plant in the world is that at Keokuk, Iowa, on the Mississippi River. The ultimate installation contemplates thirty turbines, each having a rated capacity of 10,000 hp. at the normal head of 32 ft. At the maximum head of 39 ft. the output of each of these will be about 14,000 hp. and at the minimum operating head of 20 ft. approximately 6,000 hp. The operating voltage is 110,000.

The Klamath River hydro-electric development of the California-Oregon Power Co. is situated 13 mi. east of the Southern Pacific Railroad station at Thrall, Calif. This company is now distributing 20,000 hp. in a territory of 10,000 sq.mi. in Southern Oregon and northern California. The plant recently completed will furnish 53,000 hp.

One of the largest water powers in this country will be the Mt. Shasta Power Co.'s development now in progress on the Pitt River, near Redding, Calif., at the head of the Sacramento Valley. Its position will enable it to furnish power to the mining interests and mountain railroads of northern California and to all towns and cities as far south as San Francisco and Oakland—at a maximum transmission distance of 224 mi. The interesting features are the construction of the largest water-power tunnels in the world—16x19 ft. and 36,753 ft. long. The distance from the intake portal of the tunnel to the power house will be not quite 9 mi.

The Alameda River Hydro-Electric Co. contemplates the development of 25,000 hp. from three power plants in the state of Morela, about 50 mi. from the City of Mexico. The first of these plants was started in 1912.

The McCall's Ferry development on the Susquehanna River under the most favorable conditions will have a maximum capacity of 135,000 hp. By the construction of a dam 3,000 ft. long and 50 to 100 ft. high, 32,000,000,000 gal. of water is impounded.

In the south central part of Wisconsin, on the Wisconsin River, near Prairie du Sac, a power development has been started that will have an ultimate capacity of 25,000 hp. operating under a 25-ft. head.

An important hydro-electric development in Brazil is the Pirahy plant of the Rio de Janeiro Light and Power Co., on the Lages River. The original plant had six vertical impulse wheels of 9,000 hp., each, the maximum distance of transmission being 51 mi. As a result of the rapid growth of the cities served, the demand has exceeded the original capacity of 54,000 hp. and the power house has been enlarged so as to make room for the two largest impulse turbines built to date, each capable of producing 20,000 hp. at a speed of 300 r.p.m. under a net head of 900 ft.

In 1914 the Sao Paulo Electric Co. started its plant at Sao Paulo, Brazil. The present capacity is 40,000 hp., and current is transmitted 56 mi., at 88,000 volts, to Sorocaba and vicinity. Ultimately it will have a capacity of 67,000 hp. One of the units in this plant has a capacity of 14,500 hp. under a head of 600 ft.

While formerly the gravity waterwheels were used to a greater extent than reaction or impulse wheels, the practical water prime movers today have been reduced to two—the Francis turbine and the impulse wheel. These have been applied to a range of head from 6 to over 5,000 ft. With the marked advance in the workable speed of these machines, it is now possible to develop water power under heads heretofore considered impracticable. A single-runner high specific speed mixed-flow Francis wheel has recently shown an efficiency of 93.7 per cent.

The largest single units so far constructed are the 17,000-hp. vertical Francis turbines installed at Tallulah Falls. These operate under a head of 600 ft. Manufacturers now declare that 40,000-hp. units are quite practical if the demand arises.

HIGH-VOLTAGE TRANSMISSION SYSTEMS

Niagara Falls power is transmitted to Syracuse and to Oswego at 60,000 volts. The Southern Sierra Power Co. transmits power from Bishop, Calif., to San Bernardino, Calif., 238 mi., at 150,000 volts. The Province of Ontario has been delivering Niagara Power 130 mi. and has continued its line to Windsor, a distance of 235 mi., at 110,000 volts. Already improvements are at hand permitting a still larger transmission at a voltage of 150,000. The standard generating voltages are 2,200, 6,600 and 11,000, the choice being governed by the speed and capacity of the plant. Standard transmission voltages are 11,000, 33,000, 66,000, 110,000 and above, depending on the amount of power and distance transmitted.

During the five-year period previous to 1913 improvements in insulation brought the voltages from 10,000 to 120,000, made possible by the invention of the suspension insulator. At the end of 1913 a further increase was attempted in the notable transmission from Big Creek to Los Angeles, Calif., 240 mi., at an initial pressure of 135,000 volts, to be raised to 150,000 as the load demands.

A few years ago the greatest trouble was had with high-tension transformers, but American manufacturers have now entirely overcome this. In some of the biggest foreign plants the engineers have found it desirable to come to the American manufacturers for transformers even when the rest of their plants was of home manufacture.

Thirty-one plants operate at or above 100,000 volts. One-half of these are on this continent and most of them in the United States; all but one are three-phase plants. About 40 per cent. of the total number are operated at 60 cycles, 30 per cent. at 50 cycles and the rest at other periodicities, mostly 25 cycles. There seems to be a strong tendency to use single-phase units in the transformers, although a few plants use the three-phase type.

The American Association of Engineers

By F. C. Van Etten*

Realizing that the technical engineers throughout the United States would be materially benefited if the individuals of all branches of engineering could be assembled into one working unit to further their social and economic welfare, a number of engineers formed themselves into an organization which in May, 1915, was incorporated in the State of Illinois under the name of the American Association of Engineers, with the principal office at 29 South La Salle St., Chicago.

The objects of the American Association of Engineers are "To raise the standard of ethics of the engineering profession and to promote the economic and social welfare of engineers": (1) By affording a means for the interchange of information; (2) by maintaining a service clearing house; (3) by affording patent and legal advice; (4) by supervision of legislation; (5) by proper publicity.

This association holds that the ethics of the engineering profession as determined by the existing societies is not out of harmony with the present conditions. If a change is made, it must be for the better—a change which will form a closer bond between the engineer and the public. No reflections are cast upon the ethics of the existing societies, but the program of such an altruistic organization as the A. A. E. must necessarily include references to ethics.

PROMOTING THE ECONOMIC AND SOCIAL WELFARE

In order to promote the economic and social welfare of engineers there are but two courses to pursue—by unionistic or "big-stick" methods or by getting down to broad economic principles such as supply and demand, the value of the service and coöperation between all the parties to be benefited.

The pocket nerve is truly a sensitive one. Nothing could be farther from the truth than the statement that the A. A. E. is a high-class union as some are wont to call it, as is shown in the following discussion of its policies.

It is not the intention of this association to limit the supply of engineers beyond the following procedure: Frequently trade schools and sometimes colleges and universities place before prospective students luring but misleading and highly colored advertisements relative to the compensation of engineers. Such statements the association may decide to counteract by publishing the facts, and then if the student chooses to proceed with an engineering education, he is doing so with full knowledge of the prospects ahead of him.

The most fruitful field for promoting the economic welfare of the engineer lies in that of increasing the demand for engineering services. Is it not proper that the association should endeavor to create new fields for engineering service—to place the engineer in positions that rightfully belong to him and for which he is especially fitted by education and experience, as for instance, the position of city manager? Cannot the engineer be placed in this last-mentioned position by educating the public through the lay press of the special qualifications of the engineer for such work? And is not such educational work the performance of a service to the public? Also, is it not proper that the engineer should endeavor to promote the product of his services? The product of his service will naturally include utility projects and civic improvements which will require bond issues. Is it not proper that the engineer should endeavor to influence the passage of such bond issues? It is not only proper, but it is his duty—one in the performance of which he has been derelict. Is this procedure one to which the employer of engineers can justly object? In fact, would it not be considerable of a benefit to the employer that the engineer promote such enterprises? Would not such action tend to create a stronger tie between the employer and the employee? It is this feature of the program of the A. A. E. that is particularly attractive to the consulting engineer.

The case of the doctor and the engineer are not analogous. The "ethical" combination to maintain fees and perquisites may make doctors better off as a class; the development of an antitoxin serum, or a scientifically conducted antituberculosis campaign may lead to the stamping out of a disease that brings them many patients. The association does not charge the medical profession with any such procedure, but it is evident that such a combination would restrain a benefit to the public and promote prosperity in the medical profession. But contrariwise, a combination on the part of engineers to restrain a benefit to the public would serve to the detriment of the engineering profession and, conversely, a combination to benefit the public by the promotion of utility projects and civic improvements would inure to the benefit of the engineer.

ENHANCING VALUE OF ENGINEERING SERVICES

Quite as important as increasing the demand for engineering services is enhancing the value of such services.

To become a successful physician does not require any more education or business and executive ability than is required of the successful engineer—in fact, it is quite possible that a successful engineer would total more points in such qualifications than the successful physician—but nevertheless it is true that the average physician has a higher financial rating than the average engineer. This is due primarily to two causes—the quite universal price of $2 a call and the alleged higher intrinsic value of the physician's service to the public.

The engineer is constantly striving to benefit the health, safety and convenience of the public. The chemical and mechanical engineers purify and supply the drinking water, sanitary engineers make conditions healthful by laying out drainage systems, hydraulic engineers are striving to protect communities from flood-waters; electrical, mechanical, civil, gas and telephone engineers make community life possible—but after all does the engineer receive proper recognition for this work?

A campaign to disseminate information and to educate the public to a more appreciative attitude (channel No. 5) would result in greater recognition of the engineer.

The engineer must realize that while the public is the ultimate consumer of his services, he is the trustee of the public's welfare and health. Any propaganda to promote the welfare of engineers but at the same time ignoring this fact would defeat its own purpose.

THE ENGINEER'S DUTY TO THE PUBLIC

Since it is because of the engineer that community life is possible, it is therefore mandatory that he realize his responsibility to the public. He must protect its rights in matters pertaining to public utilities and civic improvements, and especially must he supervise the expenditure of public funds in connection with them.

A campaign to educate the engineer to the necessity of assuming public life and to educate the public to the necessity of placing the engineer in public office will be carried on in the first instance through the official monthly magazine of the association and in the second instance by the laymen's national periodicals, thus bringing into play channels Nos. 1 and 5.

The nature of the work of many of the engineers is such as to keep them confined to the office or shop, and as a result they do not mix with the public as do physicians and lawyers—that is, they are screened from the public's view and their work is known only to themselves. The association will directly compensate for this defect by urging and assisting the engineer to become more of a mixer, a social factor and a leader of thought, and indirectly by talking with the public in regard to engineers and their work through the layman's national periodicals from a layman's point of view and in a layman's language—much in a manner as has already been undertaken in "World's Work." This again brings into action channel No. 5.

The common cry against engineers is that they are very poor business men. It is just as unreasonable to expect the engineer to be a good business man as it is to expect the business man to be a good engineer. One can become a good engineer or a good business man only by experience. But this does not excuse the engineer from gaining as much knowledge of business methods as he possibly can. The association can at least keep this matter constantly before the engineer with the hope of influencing him to take up studies along commercial lines and may perhaps go even to the extent of establishing night or correspondence schools so that he may be at least informed in the fundamental principles of business.

Some have the idea that the association will attempt to supervise legislation to the exclusive interest of the engineer. Such procedure is not contemplated. The association must keep in mind the interest of the public. Engineers real-

*Secretary of Chicago Alpha Chapter, American Association of Engineers.

ize that the passage of certain laws would be for the good of the public, or perhaps it may be of greater benefit to the public if certain bills were not made laws or if some laws were repealed. The policy of the A. A. E. will be to conserve the interest of the public in matters of legislation, as well as the interest of the engineer, by assisting legislators of the various state, municipal and national bodies to treat subjects of a technical nature with scientific enlightenment.

The association will take up patent and legal matters of common interest. It is not the intention to consider cases of individuals unless their settlement is of interest to the engineers as a class. To attempt to prosecute patent applications or patent litigation for individuals would certainly attract a volume of business, for there are many who have ideas to patent without having the necessary capital; but such procedure would be entirely out of the question.

The association, through its monthly publication, will keep the engineers informed in patent and legal matters. Few technical men fully understand the constitutional rights of inventors, what a patent right really is or what right an employer has in connection with the development work performed by his employees. Instruction in this and other patent and legal matters will be of great import to the profession.

THE SERVICE CLEARING HOUSE

Each member is being classified as to education and experience by the qualification committee, and employers may refer their wants in the technical vocations to the association.

The first object of the Service Clearing House will be to place a man in a position on the assumption that it is better to be employed than to be idle, and secondly to place the right man in the right position on the theory that a man can do his best work and be of more service to his employer when he is performing work that is interesting to him and for which he is especially adapted by education and experience. Frequently a man does not seek more congenial employment simply because he is employed and consequently does not get the opportunity to investigate. To such a man the association will be of invaluable assistance because it pursues a policy of persistent watchfulness for the proper openings.

Incompetent men are not desired in the association. Nothing could do it more harm than to have a number of incompetent engineers in its ranks, and therefore it behooves the association to carefully guard its membership against such. The employer welcomes the opportunity to deal with an organization whose members' records are honest and clean and upon whom he can rely. To show the attitude that the association wishes its members to assume toward their employer, the following extract is taken from "The Monad," the official publication of the association, and while no definite action has been taken, it expresses the sense of the organization:

1. The A. A. E. shall solicit and secure the confidence of the employers by offering them efficient, competent and loyal help.
2. It should help its members by all fair means and without charge to the employer or member to obtain a position and compensation befitting the man and his qualifications.
3. It should reprimand any member guilty of unethical conduct toward his employer or toward the profession.
4. It should absolutely repudiate such methods as intimidation, strikes and insubordination and should condemn any dishonest method used by some employment agencies. It should discourage the supplying any member a change of position without his previous written request for the change.
5. It should expect each member to merit a just recompense for services rendered, by giving a fair day's work for a fair day's pay, being prompt and industrious, thereby making possible a profit to the employer by this efficiency, and then each member should demand such just recompense.
6. Each member should remember that the employer, whether he be a corporation, a municipality or an individual, is our customer and a satisfied customer is our asset.

Members will be kept informed as to the condition of the market for their services throughout the various portions of the country, as it would be most inexpedient to have a flow of service toward a section where already a poor market exists.

The cost of obtaining employment is often a serious matter with the average engineer at a time when he can least afford it. For that reason the association feels that eventually it should discourage employment agencies.

Another service that the Clearing House can render is in the nature of what might be termed "social or vocational engineering." This service will be of particular value to young engineers just emerging from college and who are accepted as junior members.

The association will know the average salaries paid to the men in the various fields of engineering endeavor and also the length of time the men have been active in their respective lines of engineering. Sufficient data will then be at hand to plot curves showing the relation between the salary of the average engineer and the years of experience which he has to his credit.

The young engineer can see what phases of engineering are the most profitable, and if he has average ability and opportunity, he can estimate to some degree of certainty what his income will be 10, 15 or 20 years hence. The association will also be in a position to study the characteristics required for any particular phase of engineering and to assign weights to them in accordance with their degree of importance in each line of endeavor. The embyro engineer can then list his characteristics and weight them according to his judgment or in accordance with the judgment of his associates or members of the association, and he will be in a position to select that particular phase of engineering which will be the most profitable to him and for which he is particularly adapted by inclination, education, experience and characteristics. In other words, the association will be the laboratory of the profession in which data are taken, recorded and used to advance the engineer and the engineering profession.

THE NEED OF ONE NATIONAL ASSOCIATION

The aims, policies and methods of the A. A. E. have been enumerated in as much detail as space will allow. There are other activities which perhaps have been omitted, all of which are of the highest character; and there are doubtless other lines of activitity which will suggest themselves with further study. There has been one serious consideration which must be emphasized and that is the need of one national association to promote those interests of engineers which are common to the various classes of the profession. Many realize the importance of the program of this association, but are of the opinion that the work should be carried on by the existing societies. This is a natural conclusion, but on further study it will be seen that such procedure is not improper but impossible for the existing societies. Large amounts of money must be expended, and the undivided time of a number of engineers will be required. The work must be carried on efficiently and should therefore be directed by one central department. Coöperation between the existing societies is suggested, but such procedure is entirely out of the question. First, because of the expense—the existing societies cannot divert sufficient funds from their treasuries to carry on this work. Second, the programs of the existing societies are so foreign to that of the A. A. E. Their programs are those of promoting scientific research and the advancement of engineering practice; that of the A. A. E. is to advance the engineer, his business ability and his commercial interests—a strictly business proposition. Third, all the coöperation possible between the existing societies cannot produce the results as efficiently and as economically as the concentrated effort on the part of a single organization maintaining a detail of men whose sole purpose is to promote the welfare of all engineers. Large organizations spell economy, efficiency and strength.

The American Association of Engineers is not antagonistic to the present societies. It extends to all the most hearty cooperation, and it is the hope that this organization will become the binder for all the existing organizations—a common meeting ground for the men in the various special lines of engineering work.

Engineers how long will you persist in the doctrine of self-abnegation? Awake! Arise! Advance! Combine our opportunities and procure engineering recognition and triumph eventually!

Briquetted Lignite Coal*

Lignite coal has no value commercially very far from its source, for upon drying it slacks and crumbles to dust and as such it cannot be used for many purposes with economy. It is for this reason that it is briquetted. The analysis of lignite varies somewhat according to the locality in which it is mined, but the following is a fair average: Moisture, 35; volatile gases, 29; fixed carbon, 28; ash, 8.

The plant of the Northern Briquetting Co. is the only one in the United States, and perhaps in the world, that is commercially working on the grade of lignite obtained in North Dakota. As the first and only one, the plant has had its troublesome experiences, but today it is doing first-class work, turning out from 50 to 70 tons of good briquettes per day of ten hours.

From the tipple at the mine the coal is run by car to the ovens and charged in at the top. These ovens of which there are ten are of the beehive type used in Pennsylvania, and while not especially adapted to the lignite coal, they were erected for use until something better could be designed. Each holds about eight tons of coal, which remains in the

*A paper read before the North Dakota Society of Engineers by H. L. McDonald, manager of the Northern Briquetting Co., Minot, N. D.

oven 48 hr., after which the moisture and volatile gases are supposed to have been largely driven off, and the charge is drawn at the bottom, the fire quenched and the residue loaded into hopper-bottomed cars and freighted to the plant. Five ovens are charged each day and five drawn; thus half the ovens are coking continually. At the plant the residue is unloaded into a pit and elevated to the storage bins. The mechanical process of making briquettes is merely the mixing of the coal with some sort of a binder and pressing the whole into a mold.

The lignite residue is drawn from the bins by a drag chain in a screw conveyor, which takes it to the pulverizer, where it is mixed with a little coking coal and crushed to a fine dust, the finer the better. From the crusher the residue is elevated to a preheater, where it is heated to about 150 deg. F. and then dropped into a steam-jacketed mixer with live steam and water and later blended with hot pitch. After passing this machine, the mixture goes through two coolers, then to the rolls, or press, where it is formed into briquettes and delivered by an elevator to the cooling table and then to the bins. The coal-tar pitch used in this plant is heated in two different tanks—in the final one to a temperature of 260 deg. F.—and is then pumped to strike the coal mixture halfway down in the mixer.

The press is of the roll type with forty pockets in each row around the roll and seven rows wide, making 280 briquettes to each revolution. The rolls revolve 7½ to 8 times per minute, and the press has a capacity of from 7 to 8 tons per hour. The briquettes are pillow-shaped, weigh about 2 oz. and are clean and easy to handle. A little coking coal is used to bind the briquettes together after they are in the fire, for lignite has no coking properties itself and unless the bituminous coal was added the briquettes would fall to pieces.

In the mechanical making of the briquettes the biggest problem is to keep the proper amount of moisture and other ingredients in the mixture, as conditions and the material vary quickly and frequently. If the mixture is too wet, the briquettes are liable to freeze before they are dry. If it is too dry, the binder will not mix thoroughly with the coal and balls will form which will gum up the rolls and necessitate shutting down until the pockets can be cleaned. It is not so much a question of how well the machinery may work, as of how close a watch is kept at the first mixer, where the steam, water and pitch are added.

The real problem confronting the engineer and one on which many men have worked for years is that of building some sort of an oven from which a good residue can be obtained and at the same time the byproducts collected and commercially used. Lignite does not form a coke as do most bituminous coals, but rather a residue, and in the beehive ovens used at the Northern Briquetting Co.'s mine, there are no provisions for saving the gas or any other byproduct, and at the same time the ovens are not efficient in the making of the residue. It can be seen that the more byproducts saved and utilized, the cheaper the briquettes can be made and the more ways opened for using and developing the lignite-coal field. The experimental station at Hebron has plans for the modification of these ovens; and several engineers in other parts of the country are working on plans for ovens whereby the moisture and gas can be driven off and utilized, the coarse product to be used for gas producers, the fines briquetted and other byproducts saved.

Some Aspects of Boiler Efficiency

At the fifteenth annual convention of the Illinois State Electric Association, held at the University of Illinois, Urbana, on Feb. 23 and 24, 1916, H. J. Klotz read a paper on "Some Aspects of Boiler Efficiency." To show the importance of the coal item the author cited annual operating reports from fifteen moderate-sized plants ranging from 1,000- to 9,000-kw. capacity, in which the cost of coal averaged 63 per cent. of the total cost of generation; the individual plants range from 50 to 75 per cent. To obtain the highest over-all economy, Mr. Klotz emphasized the importance of operating boilers at high rates of combustion and maintained that while the individual boilers might operate at slightly lower economy, the load could be carried with fewer boilers, which would result in cutting down radiation and other losses so that the economy of the plant as a whole would be improved. In bettering the economy another step of first importance is to maintain clean heating surfaces, keeping the tubes free of scale on one side and soot on the other. This is of particular importance when operating at high capacity.

To secure proper combustion the design of the furnace and the manipulation of the fire are the leading factors. These designs are of necessity functions of the fuel and the type of boiler, and the limitations have proved to be limited. As an example of the effect an apparently insignificant variation would have, Mr. Klotz gave some data on a flat ignition arch for a chain-grate stoker burning Illinois screenings. In a certain installation the height of the arch from the grate was 11 in. Good ignition could not be secured, so the arch was raised to 13 in. A great improvement was at once evident, and in the hope of doing still better the arch was made higher, being raised to 15 in. The ignition proved to be again poor, and the fire was not getting a start at the feed gate as it should. In this case two inches either way was detrimental to combustion.

For continued attainment of high boiler efficiency the manipulation of the fire is a big feature. In this are included the proper depth of fuel bed, the draft maintained and the rate of firing. The effect of leakage of air into boiler settings is of sufficient importance to warrant special coverings. In this connection reference was made to an effective covering consisting of asbestos plaster on wire mesh, sometimes covered with canvas and painted, also to the latest method of incasing the whole setting in sheet steel. Loss by radiation was being reduced by the use of insulating brick.

Accurate tests to determine the best operating conditions for different loads were considered important, and it is especially desirable that these tests should be so conducted that they will be comparable one with the other. After the tests to determine the methods of operation productive of the highest efficiency, means must be provided whereby a constant check on the operation can be kept. The auditors' monthly report will show up decreases in efficiency in the course of time, but too late to be of much service. An ideal condition would be to have each boiler so equipped that each day's operation would be in effect a more or less complete test. This is, of course, a long stride and not altogether necessary. Equip the boilers with draft gages and provide a means of sampling the flue gases to determine the percentage of CO_2, and the instruments have been provided to maintain efficiency. As an additional guide a steam-flow meter can be used to advantage. To an indicating meter of this type it is possible to add scales that will show the proper thickness of fire and correct draft to carry for each load.

MORE THAN INSTRUMENTS NECESSARY

The mere provision of the instrument is not an assurance of efficiency. In a certain plant well equipped with instruments efforts were being made to bring up the CO_2 on a certain boiler. At last it was believed that the results obtained were the best possible under existing conditions. The CO_2 averaged 11½ per cent. A good-sized opening around the stoker frame at the rear was detected, and after this was patched up the percentage of CO_2 in the flue gases jumped to 15. An instance was given of another plant which, it was claimed, never possessed a draft gage or gas analyzer, yet the results were far ahead of similar plants equipped with instruments. This merely shows that if the principles conducive to higher boiler efficiency are practiced, the efficiency will be secured without the instruments. There are few plants able to observe these principles in the dark, and it is taking a long chance to try it without reliable instruments.

While the percentage of CO_2 in the flue gases is a valuable guide toward obtaining maximum efficiency, there is a tendency in some plants to put too much reliance on these readings. With chain-grate stokers the percentage of CO_2 can be raised by maintaining a long fire, which means that unburned coal will be carried into the ashpit. Obviously it does not pay to obtain a high CO_2 if coal is thrown away to do it.

After all, the human element is of the greatest importance. It is the firemen who have it in their power to be the deciding factor as to the direction in which the coal bill will vary. No amount of excellent work on the part of efficiency experts will effect a saving that will show on the auditors' balance sheets if the coöperation of the men in the boiler room is not secured to carry out the program outlined. An incentive in the form of additional compensation in proportion to the amount of savings effected seems to be the logical solution to hold their interest, and it is fair to both the men and the company.

In the average plant the fireman's payroll is from 10 to 15 per cent. of the coal bill, while savings as high as 25 per cent. of this item are commonly reported, showing that there is considerable latitude for the adjustment of a bonus. In addition the physical conditions under which the men have to work must be so arranged as to insure the fullest preservation of their strength, health and physical faculties. The absence of elementary conditions of comfort in the working place where the men spend the better part of their lives is more harmful to the employers than to the employees.

Senate Passes The Shields Bill

After exactly one month of argument and prolonged debate, the Senate, by a vote of 46 to 22, passed the Shields water-power development bill on Mar. 8. The measure now goes back to the House of Representatives for consideration of the amendments that the Senate introduced into the bill. It is probable that it will be several weeks before the House will act in this matter, and if any more changes are made, the bill will have to come back to the Senate, where it will go to conference for some time before being again acted upon by the upper house of Congress as a whole. Senator Shields and others who are vitally interested in the measure state that they hope the bill will be enacted into a law at the present session of Congress, but that there is some doubt whether the National Legislature will find time again to consider it. The European situation and the preparedness question are taking up so much time that other matters may be forced to lie over until next winter.

The debate on the Shields bill during the last three days of its consideration in the Senate was particularly heated, and the advocates of the bill in its original form were forced to keep continually on the alert to prevent the introduction of amendments and changes.

The first of these attempted changes was that suggested by Senator Walsh of Montana, who wished to change the measure so that at the expiration of the fifty years' lease the Government might recapture the dam or power site by the payment only of the cost of the property and that the "unearned increment should accrue to the benefit of the people, instead of to the benefit of the corporation." By a vote of 32 to 21 the Senate rejected this amendment.

After rejecting another Walsh amendment by a vote of 33 to 23, the Senate proceeded to a consideration of the substitute bill sponsored by Senator Husting of Wisconsin and introduced as a "conservationist measure" to take the place of the entire Shields bill. In the course of his discussion of the substitute bill Senator Husting launched a sharp attack upon the provisions of the Shields bill, which he characterized as "an attempt to get the water power of the country developed without proper supervison of this development." He said:

There are two lines of thought on this subject. There are those who believe that licenses should be issued to promoters and to those companies which desire to develop our water powers on terms so generous, so oblivious to the interests of the people, for the purpose, they say, of causing immediate development. In other words, these men believe that it is for the best interests of the country to develop these water powers immediately and expect the public in a general way to content themselves with reaping some benefit as an incident to such development. They belong to that school of thought that teaches that if you look out for the captains of industry of a country, if you look out for capital, the benefits will trickle down and through to those below.

The other line of thought, and the one that I try to follow, is that when you take care of the just measures of the people first, that when justice is done to them, that when they prosper, then capital will profit and the captains of industry prosper. That is a good democratic doctrine, and therefore I believe that in disposing of a great national resource it should be disposed of in such a way that the benefit to the people shall be made certain; that it shall not be left to those who engage in this business to give the public benefits from it, but that they should be secured in these benefits by the Government itself.

The bill proposed by the committee, in my judgment, is a bill that has for its purpose primarily the promotion of water-power development, with practically no provision of an adequate nature for preserving the public rights or the Government's rights in these waters. I think it was framed upon the plan and upon the theory that the people have little, if any, interest in navigable streams except their navigability and that the water powers incident to their improvement should be given to whomsoever we may choose to favor for as much as they can get out of them and that the future may take care of itself, so far as the people's interest therein is concerned.

There is another feature to this. Have we any right, as trustees of the people of the United States to tie up these resources forever? Have we any right to surrender our powers—powers that have been delegated to us as the representatives of the people of this country, so that they will be beyond the reach of posterity? In other words, have we the right to legislate for all eternity or shall we legislate in such a manner that some time in the future the representatives of the people may be able to legislate in the light of these times and the light of their then necessities?

Senator Husting's two-day argument in favor of the substitute amendment was of little avail, for only 13 Senators voted in favor of it to 44 opposed. Those who favored the conservationist measure were: Gore, Hollis, Husting, James, Kenyon, La Follette, Lane, Lea, Martine, Newlands, Norris, Poindexter and Reed—nearly all attached to the Progressive wing of either party.

The attempt by Senator Norris of Nebraska to attach to the Shields bill a rider providing for the construction by the Government, at an estimated cost of $15,000,000, of a power plant on the Great Falls of the Potomac, to provide the City of Washington with electricity, was tabled by a vote of 30 to 28. Senator Norris served notice that he would again attempt to include this provision in the Shields bill when the measure returns to the Senate.

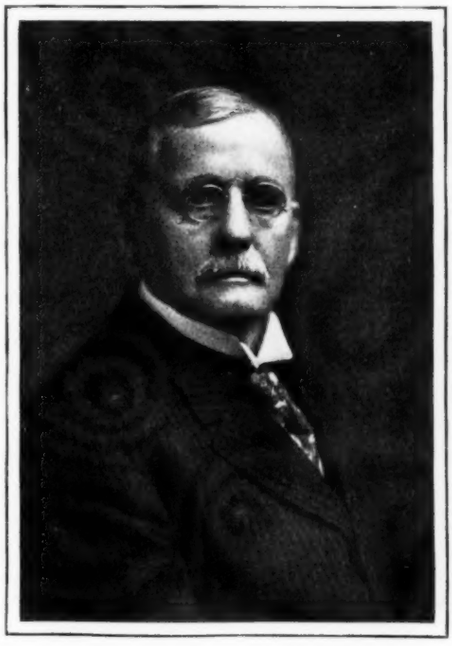
Senator Newlands of Nevada tried without success to attach to the bill his measure providing for a waterways commission and appropriating $60,000,000 annually for ten years for flood control, waterway improvement and soil protection. An amendment by Senator Chilton of West Virginia, requiring the Secretary of War to decide contests for permits to build dams in favor of the applicant offering the lowest-priced service to the people, was defeated, 30 to 21, and the question of the passage of the bill was then presented to the Senate.

The final vote stood 46 to 22. Those who voted against the bill were: Senators Ashurst, Borah, Chamberlain, Chilton, Cummins, Gronna, Hollis, Husting, James, Kenyon, La Follette, Lane, Lea, Lee, Lewis, Martine, Newlands, Poindexter, Reed, Sheppard and Works

OBITUARY

JOHN C. HOOVEN

Col. John C. Hooven, president of the Hooven, Owens, Rentschler Co., builder of the Hamilton Corliss engines, died at his home in Hamilton, Ohio, Mar. 1. He was born in Montgomery County, Ohio, Sept. 29, 1843, and was educated in the public schools of Franklin, Ohio. In 1864 his father and he established a hardware business under the style of Hooven & Son, in Xenia, Ohio. Ten years later, removing to Hamilton, the firm became Hooven & Sons and engaged in the agricul-



JOHN HOOVEN

tural-implement business. In 1878 John C. Hooven became sole proprietor, and at this time the products were especially the Monarch portable engines, threshers and sawmills as perfected by Mr. Hooven. In 1880 the present company was formed and two years later incorporated, beginning then to build Corliss engines. J. C. Hooven was the first president and continued in that office until his death.

In 1900 the business of the company demanded a doubling of the capacity of the plant, and additions were completed in 1901. Very large machinery became a specialty of the company. Notable among products in this class were the large engines for the St. Louis World's Fair, later the gas engines for the Ford Motor Co. and more recently huge sugar mills.

With all his devotion to this plant Mr. Hooven found time to take active interest in other enterprises. In 1895 he organized the Hamilton Rifles and was made colonel of the company. He was also president, from the time of the death of John M. Long, of the Republican Publishing Co. In 1895 he organized a traction company to College Hill, which later became a part of the Ohio Electric Railroad Co. system and

later organized the Cincinnati, Lawrenceburg & Aurora Traction Co. He also organized the American Frog and Switch Co., of which he was vice-president; the Dayton Rubber Co., the Cincinnati Horseshoe Co. and the mercantile business of Creighton & Hooven.

He served during the Civil War in the 146th Regiment, Ohio Volunteer Infantry. He was married Nov. 21, 1867, to Jennie Enyeart, of Troy, Ohio. They had five children, all living, and the widow also survives. The four sons are connected with the business—C. E. Hooven is treasurer and manager of the Hooven, Owens, Rentschler Co.; Paul Hooven, Boston representative; Enyeart Hooven, Chicago agent, and Don Hooven, purchasing agent.

Colonel Hooven was a Mason and a member of the Knights Templar.

FRANK H. VARNEY

Frank Hastings Varney, one of the best-known electrical engineers of the West, died in San Francisco, Jan. 21. He was born and educated in San Francisco and at the age of 22 started his engineering career in the employ of the Harbor Light and Power Co.; and when that was absorbed by the California Edison Co., he took charge of its Stevenson St. station. In 1908, when the San Francisco Gas and Electric Co. bought out that concern, Varney was made chief electrician in charge of three local plants where electricity was generated by steam power. He rose from this position to that of superintendent of stations in San Francisco, and when the San Francisco Gas and Electric Co. became a part of the Pacific Gas and Electric Co. combine, Frank Varney was placed in charge of the steam section of the operation and maintenance department, having under his immediate supervision the huge steam-electric plant at the Potrero in San Francisco and also those at Oakland, Sacramento and San José.

The following tribute by John A. Britton, vice-president and general manager of the Pacific Gas and Electric Co., is the expression of a fine appreciation by one good fellow for another than whom no better is made:

Loyalty, fidelity and devotion are traits of character worthy of emulation; to possess them is to have achieved a distinction among men, and if to them be added the attribute of gentleness, the combination marks one who needs no words of adulation, no monument to his memory. Possessing all of these marks and, withal, strong, fearless, brave and self-sacrificing was Frank H. Varney. Lovable as a child, in physical might a giant, fearless as those who know not wrong, he wrought his way along the highway of life, with always the thought of others, their happiness and pleasures, yet building, ever building up the structure of noble manhood—and building in a physical way for those he served—with untiring energy and skill bettering things tangible and intangible—always striving for excellence and always accomplishing it—loving, devoted, a home-resting husband and father.

The world of labor and resolve and full accomplishment of purpose needs no shafts of granite to commemorate performance of duty; that which a man has builded in helpfulness of fellow-men is as imperishable as stone or marble. The results tangible are sepaking daily in tongues that such men as Frank understood.

As hour by hour, and day by day, and year by year, those great steam leviathans builded by him revolve in endless cycles, they will sing the song and tell the story of him who builded well; the steam that creates the energy will over and over again recite his virtues, so that we will not forget.

And so "Au revoir," Frank; death has written for your physical being the word "finis"; but in love and affection your associates have written the word "remembrance"; for to them, when thoughts recur, there are no such words as "good-by."

Recent Court Decisions

Digested by A. L. H. STREET

Development of Power as a Public Use—Relying upon the well-settled principle of constitutional law that private property cannot be condemned for private use, it was recently asserted before the United States Supreme Court that a power company operating in Alabama was not entitled to condemn certain lands and water rights of a manufacturing company as an incident to the production of power, albeit the power is intended for sale to the public. In overruling this contention the highest court of the land, speaking through Mr. Justice Holmes said:

The purpose of the power company's incorporation and that for which it seeks to condemn property of the plaintiff in error, is to manufacture, supply and sell to the public, power produced by water as a motive force. In the organic relations of modern society it may sometimes be hard to draw the line that is supposed to limit the authority of the legislature to exercise or delegate the power of eminent domain. But to gather the streams from waste and to draw from them energy, labor without brains, and so save mankind from toil that it can be spared, is to supply what, next to intellect, is the very foundation of all our achievements and all our welfare. If that purpose is not public, we should be at a loss to say what is.—Mt. Vernon-Woodberry Cotton Duck Co. vs. Alabama Interstate Power Co., 36. "Supreme Court Reporter," 234.

Plainfield, N. J., Gets Free Lighting Privilege

An important and far-reaching decision was handed down by the New Jersey Court of Errors and Appeals on Mar. 6, holding that the agreement made by the City of Plainfield and the Public Service Electric Co. for free lighting service for the municipal buildings is valid and sustainable and may be properly enforced.

This decision terminates an extended and important controversy indirectly affecting all municipalities in the state in their relations with public-utility companies. It expresses a reversal of the Supreme Court's ruling recently made in connection with this case, which held that free service was not permissible under the public-utilities law and that the language of such law was not broad enough to confer power on the Board of Public Utility Commissioners to enforce the specific performance of the contract.

In granting a franchise to the company in 1898, the city contracted with the company for free lighting for the city hall, firehouses and other municipal structures. Operative while the company enjoyed its franchise, the city received notice in December, 1913, that on and after Feb. 1, 1914, this feature of the contract would be discontinued, as such was in violation of the public-utility law, adopted in 1911, prohibiting undue and unreasonable discrimination in rates for electricity.

The city contested this concellation of the contract with an appeal to the Board of Public Utility Commissioners, which, after a hearing, decided that the city's contention that the free lighting provision was not a discrimination should be upheld, and ordering the company to fulfill this agreement. The company appealed this decision to the Supreme Court, which, on Mar. 27, 1915, reversed the order of the Public Utility Commission.

On the city's appeal to the Court of Errors and Appeals, this tribunal by unanimous decision decided that the special provision in the agreement must be carried out by the electric company. In its ruling the court says that the city in its initial appeal to the Board of Public Utility Commissioners did not seek the proper tribunal to maintain its rights, as the order to fulfill the specific performance of this contract was an equitable power exclusively residing in the Court of Chancery; that the public-utilities law is prospective and not retroactive, and hence could not be applied to operate upon this contract, which was made in 1898, and which was lawful when made.

In its litigation with the company, the City of Plainfield was joined by Newark, Passaic and Jersey City, as well as the New Jersey State League of Municipalities.

PERSONALS

Maynard D. Church has been promoted from assistant to chief engineer of the Terry Steam Turbine Co., Hartford, Conn.

G. L. Kothny has left the Westinghouse Machine Co. to go with the C. H. Wheeler Manufacturing Co. as consulting engineer.

E. P. Worden, formerly of the Fred M. Prescott Steam Pump Works, Milwaukee, Wis., has been appointed chief engineer of Henry R. Worthington, Harrison, N. J.

Jiles W. Haney has resigned as chief engineer of the Commerce Power Co., Kansas City, Mo., to become an instructor in mechanical engineering at the University of Missouri.

William F. Lathrop has taken charge of the Milwaukee office of the Woodmansee-Davidson Engineering Co., of Chicago. He was formerly assistant to the chief engineer of power plant of the Milwaukee Electric Railway and Lighting Co.

J. E. Lawton, Mem. A. S. M. E., for the last nine years inspector and chief inspector of the Panama Canal, has resigned to accept a position as consulting engineer and sales manager for Ward & Co., manufacturers' agents, at Washington, D. C.

James D. Andrew, superintendent of the station engineering department of the Edison Electric Illuminating Co., Boston, Mass., is on leave of absence in Chile to make a report on the 40,000-kw. power plant of the Chile Copper Co., a large extension to which is contemplated.

Dr. F. W. Cunningham, of Orange, N. J., has resigned his connection with the research and development work of the Newark plant of the General Electric Co. to join the engineering research staff of the Powdered Coal Engineering and Equipment Co. of Chicago.

P. P. Bourne, formerly chief engineer of the Blake & Knowles Steam Pump Works, East Cambridge, Mass., is again associated with the International Steam Pump Co. in connection with special engineering work, and is located at the company's main office, 115 Broadway, New York.

J. M. Hopwood has resigned as superintendent of power for the West Penn Traction Co. to become sales manager of the stoker department of the George J. Hagan Co., Pittsburgh, Penn., which represents the Combustion Engineering Corporation in Pennsylvania, West Virginia and eastern Ohio.

Frederick W. Ballard, of Cleveland, Ohio, who has charge of that city's municipal lighting, has been appointed by the City of Memphis, Tenn., as appraiser on the board which will determine rates for current from the Merchant's Power Co., of that city. He is to receive $10,000 for his services.

J. D. Bowles, superintendent of the electric department of the Springfield Gas and Electrical Co., Springfield, Mo., has been named chairman of a committee of the Association of the Missouri Public Utilities Companies to draft uniform rules and regulations governing the construction of overhead and underground lines maintained by the electric-light and traction companies of Missouri.

H. M. Montgomery, for many years Western representative of the Alberger Pump and Condenser Co. and more recently of several other interests, has associated himself with C. W. Humphrey, consulting and contracting engineer, who specializes in the design and construction of hydro-electric steam and industrial plants, in electrical transmission and distribution and in water-works, also in reports and valuations of like properties, under the firm name of Humphrey & Montgomery, at 327 South La Salle St., Chicago.

ENGINEERING AFFAIRS

The American Order of Steam Engineers will hold its thirtieth annual convention during the week beginning Monday, June 26, at the Hotel McAlpin, New York City. The American Supply Men's Association will have an interesting mechanical exhibit in connection with the convention.

Philadelphia Joint Engineering Meeting—The Philadelphia sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers will hold a joint meeting Apr. 10. The subject will be "The Possibilities of Some Prime Movers Now Under Development," including Diesel engines, unaflow engines, locomobiles and steam-gas units.

New Haven Joint Engineering Meeting—A joint meeting of the mechanical, electrical, civil and mining engineers of that vicinity will be held at New Haven, Conn., Apr. 5, in the Mason Laboratories of the Sheffield Scientific School of Yale University. At the evening session there will be an illustrated address by Samuel Insull, president of the Commonwealth Edison Co., Chicago, Ill., on "The Progress of Economic Power Generation and Distribution."

Atlantic City Council, A. O. S. E., held is nineteenth annual dinner at the Jackson Hotel, Saturday evening, Feb. 26. About 125 were present. At intervals the guests were entertained by vaudeville talent. When the coffee was reached. the toastmaster, A. H. Franks, introduced William Bartlett, commissioner of public safety; William Le Compte, of Jenkins Bros.; Harry Bacharach, commissioner of parks; and William Pairent, who gave short and interesting addresses. During the evening Billy Murray, of Jenkins Bros., sang songs, and Jack Armour told stories and recited.

Jersey City Association No. 1, N. A. S. E., held its thirty-fourth annual entertainment and reception at Elks' Hall, Friday evening, Feb. 25. There was the usual big attendance of prominent engineers and supplymen. A good entertainment was furnished by "The Bunch" and was followed by dancing. Frank Martin, of Jenkins Bros., was the stage director. The officers of the Association are: Dennis F. Bartley, president; Frank A. La Pointe, vice-president; A. H. Krohne, treasurer; Martin J. Hickey, financial secretary; Robert Woodman, recording secretary; P. J. Supple, corresponding secretary; C. J. Storzinger, conductor; Allen Canning, doorkeeper.

American Society of Mechanical Engineers—On the way to the spring meeting of the society at New Orleans, Apr. 11-14, there will be a stop-over at Birmingham, where the members of the party will be the guests of the Birmingham section. The opening session at New Orleans will be on "Industrial Preparedness," with a paper by Spencer Miller. Other subjects to be discussed during the meeting will include "Multiple Evaporators," "Low-Lift Pumping Plants in the Gulf-Coast Country," "Mechanical Equipment Used in the Port of New Orleans," "Measurement of Flow of Liquids," "Dynamic Balance of Machine Parts," "Center Crankshafts of Gas Engines," "Transmission of Heat," "Fuels," etc. Other features of the meeting will be an excursion on the Mississippi River, with an inspection of the harbor facilities and the new cotton warehouses, and a social entertainment on Thursday afternoon, with a reception and dance in the evening.

BUSINESS ITEMS

The Philadelphia Office of the Richardson-Phenix Co., Milwaukee, Wis., has been removed to 1218 Chestnut Street.

The Bruce-Macbeth Engine Co., 2107 Center St., Cleveland, Ohio, has recently made sales of gas engines aggregating 1410 hp.

The New York Office of the Ohio Brass Company, Mansfield, Ohio, is now located at 1822 Cortlandt Building, Hudson Terminal, 30 Church St.

Mr. Benj. G. Fernald, manager of the New York Office of The Kerr Turbine Company, Wellsville, N. Y., has been elected a Director and Vice-President of the Company.

The A. S. Cameron Steam Pump Works, 11 Broadway, New York has just issued Catalog No. 154 describing and illustrating Cameron Centrifugal Pumps, and Catalog 110 describing the Cameron line of Duplex Pumps. Copies of these catalogs will be sent free on request.

The National Tube Co., Lorain, Ohio, has ordered a 15,000 hp. Westinghouse motor for driving a 40-in. reversing rolling mill. A similar order has also been received from the Indiana Steel Co., of Gary, by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Penn.

The National Ammonia Co., of St. Louis, Mo., is this year sending out a sulphur taper, which is useful in the detection of ammonia leaks in exposed coils. It also sends, on request, copies of the National booklet containing sensitive paper and describing the caustic soda test for detecting leaks in brine and water mains.

"The Barrel Book" is a new handbook on barrels, which takes up the question of the most suitable barrel for oil. It is based on the actual experiences of 16 leading coopers and extensive inquiries among oil shippers and is educational in its character. Readers can secure a copy by writing to J. E. Watterson, Corresponding Secretary, 1420 Illuminating Bldg., Cleveland, Ohio.

Classified Ads

Positions Wanted
Positions Open
Civil Service Work
Employment Agencies
Labor Bureaus
Business Opportunities
For Sale
Wanted
Agents and Salesmen
Contract Work
Miscellaneous
Educational
Books
Proposals

RATES: Positions Wanted, 3 cents a word, minimum charge 50 cents an insertion, payable in advance. Other advertisements, 5 cents a word, minimum charge $1.00. Count 4 words for blind address care of our New York or Chicago offices. Advertisements for bids $3.60 an inch.

ANSWERS addressed to us at 10th Ave. and 36th St., New York or 1144 Monadnock Block, Chicago will be forwarded without charge (excepting circulars or similar literature).

IMPORTANT: Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents—send copies. Advertisers' names will not be furnished under any circumstances. Copy received until 10 A.M. Tuesday for following Tuesday's issue. P

POSITIONS OPEN

Pennsylvania

DETAIL DRAFTSMEN wanted; one experienced in air-compressor work; also one experienced in oil and gas engines. Address P739—Power, giving references; state age and salary wanted.

GAS ENGINEER, to operate a producer-gas power plant; a man familiar with double-acting horizontal engines preferred; state age, experience, salary expected; location eastern Pennsylvania. P744—Power.

SEVERAL FIRST-CLASS DRAFTSMEN wanted at once, of general mill and blast furnace experience; state age, experience, present salary and salary wanted in first letter; also when available; central location, Pittsburgh. P687—Power.

SEVERAL DRAFTSMEN wanted at once, experienced in power plant and general piping work; state age, experience, present salary and salary wanted in first letter; also when available; central location, Pittsburgh. P688—Power.

Employment Agencies

CORRESPONDENT

THE UNDERSIGNED plans and conducts correspondence for positions in technical, manufacturing and professional lines; $2500 to $15,000 men exclusively; complete privacy assured; no commission charged—only service fee and postage. Send name and address only, in confidence, for prefatory details. R. W. Bixby (established 1910), P1 Niagara Square, Buffalo, N. Y.

POSITIONS WANTED

Connecticut

CHIEF ENGINEER open for position; 20 years' experience in large plants; highest efficiency assured; strictly temperate; best of reference. PW746—Power.

Iowa

CHIEF ENGINEER in a small plant or operator in a large plant; 12 years' experience with steam, electric, refrigerating, pumping and condensing equipment; technical education; first-class license and references; married; age 31; employed. PW737—Power, Chicago.

New York

POWER-PLANT OPERATING ENGINEER or assistant; licensed man; experienced in the care and operation of engines, boilers and auxiliary equipment; immediately available; location immaterial. PW678—Power.

ERECTING AND MAINTENANCE ENGINEER, 19 years' practical experience, desires position in charge of installing and upkeep of electrical and general industrial plant equipment; 44 years old; married. PW747—Power.

WANTED

MANUFACTURER wants either patented or patentable ideas on boiler and engine room specialties; cash or royalty basis. W676—Power.

STEAM-DRIVEN COMPRESSOR with a displacement of about sixteen hundred (1,600) cubic feet per minute; must be in good condition. W741—Power.

HAVE YOU SUCCESSFULLY SOLD a steam specialty? You can make a profitable connection with an old-established line which sells to power plants everywhere; extensively advertised—unusually liberal contract. W731—Power, Chicago.

AGENTS AND SALESMEN

AGENTS handling engine and boiler room specialties, in every section, for side line, paying large commissions. Give experience, lines carried and territory covered. W390—Power.

AGENTS on commission to sell our Shaking Grates; we will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio.

AGENTS on commission to sell the new and successful Duplex return steam trap; join a rapidly growing organization. Address American Duplex Steam Trap Co., 413 Moffat Block, Detroit, Mich.

SALES ENGINEER OR OFFICE MANAGER; have sold engines, turbines, pumps, electrical apparatus, valves and other power-plant specialties; wide acquaintance in Eastern States; desires connection. W745—Power.

MISCELLANEOUS

PATENT ATTORNEYS

PATENTS. C. L. Parker, patent attorney, formerly member Examining Corps, U. S. Patent Office, McGill Bldg., Washington, D. C. Inventor's handbook sent upon request.

IS YOUR INVENTION VALUABLE? Ask A. P. Connor, electrical, mechanical engineer (ex-chief electrical engineer for New York). Patent attorney. Lawyer. Carroll St., S. E., Washington, D. C.

For Sale

Second Hand Equipment

Rates: Less than 4 insertions 75 cents per line—4 to 11 insertions 70 cents per line—12 or more insertions 65 cents per line

Equipment Wanted items appear at the end of this list.

ADVERTISERS' NAMES are abbreviated in most of these items. Complete names and addresses are as follows:

POWER Mchy. Exchange, 14 Morris St., Jersey City, N. J.

BOILERS

150 H. P. water tube. 135 lbs. pressure allowed by inspector.—Schultz, Baujan & Co., Beardstown, Ill.

1—54"x12' Erie horiz. return tubular, butt strapped, 125 lb. —L. F. Seyferts Sons, Inc., 437 N. 3d St., Phila., Pa.

Two 250 H.P. Babcock & Wilcox water tube, 150 lb. pressure, 4 years' service; good as new, $2000 for both. Also seven 150 H.P. return tubular, butt strapped, 125 lb. pressure, fine condition, $450 each.—POWER.

Bargain, cheap before removal—3—72"x18' butt strap horizontal boilers, 125 lb., with suspension arrangement, smoke breeching, 54" stack—100' high, main header, all valves and piping; boilers practically new.—HOWARD W. READ CO., Third and Arch St., Philadelphia, Penn.

ENGINES, GAS

Westinghouse vertical, 40 hp., now running; in best possible condition. Selling because of purchase of a larger unit. Delivery immediately.—The Acklin Stamping Co., Toledo, O.

ENGINES, STEAM

American Ball engine, 160 hp., 16"x14", 250 r.p.m., with belt wheel 72"x15", new, was never set on foundation. FS722—Power.

18x36 Allis-Chalmers Corliss, latest type, heavy duty frame; practically new, $800.—POWER.

GENERATING UNITS

Engine and Generator—One Hamilton Corliss 18x36x42" horizontal cross compound engine with 14x16" cast iron flywheel; direct connected to Westinghouse 580-kw. generator, 440 v., 761 amp., 3-phase, 25-cycle, 107 r.p.m. Generator is revolving field; the Exciter is steam driven. No Switchboard with this outfit. Engine now running condensing. All of the equipment, such as pumps and piping, is in connection with the Engine. The condenser is of the surface type. 140 lb. steam pressure used. Floor space 21 ft. 8 inches wide—28 ft. long over all. Equipment has been in operation five years and can be seen in operation at our Cedar Rapids Mill. For price and full information address National Oats Co., St. Louis, Mo.

Two 75 K.W. Ridgeway direct connected generators and engines, 230 V.; practically new; $800 each.—POWER.

One turbo-generator unit, 250 k.w., direct current, 125 volts, steam pressure either 150 or 200 lbs., operation either condensing or non-condensing. Brand new A-1 condition, could be rewound for 250 volts if desired. For price and further particulars address FS743—Power.

TURBINES

We have customers who have installed larger equipment and are anxious to dispose of the following secondhand apparatus: 4 Sturtevant Turbines of horsepowers 10, 20, 24 and 35—Also one Electra Steam Turbine, 30 HP. 700 RPM, 155 lbs. steam pressure.—B. F. Sturtevant Co., Hyde Park, Boston, Mass.

WANTED

Generators and alternators—The Meriam Co., Power plant engineers, are in the market for second-hand generators and alternators, 25 to 200 K.W. Address the Meriam Co., 235 Superior Ave., N. W., Cleveland, Ohio.

Second hand Ideal engine, 200 revolutions, 16x20 cylinder. Engine built for direct connection. W733—Power.

2—250-hp. water-tube boilers for not less than 150 lb. steam pressure; must be able to stand casualty inspection. State price.—Chambersburg Ice & Cold Storage Co., Chambersburg, Penn.

Bids received until May 3, 1916.

Receiver's Sale

OF ALL THE PROPERTY OF THE
SOUTHERN IOWA RAILWAY & LIGHT COMPANY

On the third day of May, 1916, at two o'clock in the afternoon, at the North door of the Court House in Albia, Iowa. All the real, personal and mixed property of the Southern Iowa Railway and Light Company and the Albia Gas Company will be sold at a Receiver's sale to the highest bidder.

The property consists of Central Station buildings, Machinery and equipment, Car Barns and contents. Rolling Stock, Rights of Way, Rails, Ties, etc., of ten miles of street and interurban lines, Transmission and service lines, Heating Mains and service equipment, Gas Plant buildings, Machinery and equipment, Gas Mains and service equipment.

The Property has been operated by the Receiver since June 8, 1915. Statements of earnings and expenses for the period the Receiver has been in charge will be furnished interested parties.

Figures covering a recent appraisal of the property are also available. ALFRED C. MUELLER, Rec.,
Albia, Iowa.

Bids received until Apr. 3, 1916.

Boilers

St. Charles, Ill.

Sealed bids will be received by the City Clerk, St. Charles, Kane County, Illinois, for one 150-hp. Boiler.

Specifications on file at the office of the City Clerk. Bids will close at 6 P.M. on Tuesday, April 3, 1916.

P. HEMPSTEAD, City Clerk.